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ADJUSTMENT, MAINTENANCE, AND REPAIR OF CROP HARVESTING MACHINERY. AGRICULTURAL MACHINERY--SERVICE OCCUPATIONS, MODULE NUMBER 11.

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ONE OF A SERIES DESIGNED FOR HELPING TEACHERS PREPARE POSTSECONDARY-LEVEL STUDENTS FOR AGRICULTURAL MACHINERY SERVICE OCCUPATIONS AS PARTS MEN, MECHANICS, MECHANIC'S HELPERS, AND SERVICE SUPERVISORS, THIS GUIDE AIMS TO DEVELOP STUDENT COMPETENCY IN ADJUSTING, REPAIRING, AND MAINTAINING CROP HARVESTING MACHINERY. SUGGESTIONS FOR INTRODUCTION OF THE MODULE ARE GIVEN. UNIT AREAS COVER--(1) OPERATOR AND SERVICE MANUALS, (2) LUBRICANT SELECTION AND USE, (3) HAY, FORAGE, GRAIN, AND CORN HARVESTING MACHINES, AND (4) MACHINE PAINTING. EACH UNIT AREA INCLUDES SUGGESTED SUBJECT-MATTER CONTENT, TEACHING-LEARNING ACTIVITIES, INSTRUCTIONAL MATERIALS, REFERENCES, AND OCCUPATIONAL EXPERIENCES. REFERENCE IS MADE TO PERTINENT INFORMATION IN OTHER MODULES OF THE SERIES. SUGGESTED TIME ALLOTMENT IS 48 HOURS OF CLASS INSTRUCTION, AND 150 HOURS OF LABORATORY EXPERIENCE, AND 102 HOURS OF OCCUPATIONAL EXPERIENCE. THE TEACHER SHOULD HAVE EXPERIENCE WITH AGRICULTURAL MACHINERY. STUDENTS SHOULD HAVE MECHANICAL APTITUDE AND AN OCCUPATIONAL GOAL IN AGRICULTURAL MACHINERY. CRITERIA FOR EVALUATING EDUCATIONAL OUTCOMES ARE INCLUDED. THIS DOCUMENT IS ALSO AVAILABLE FOR A LIMITED PERIOD AS PART OF A SET (VT 000 488 THROUGH VT 000 504) FROM THE CENTER FOR VOCATIONAL AND TECHNICAL EDUCATION, THE OHIO STATE UNIVERSITY, 980 KINNEAR ROAD, COLUMBUS, OHIO 43212, FOR $7.50 PER SET. (JM)

ADJUSTMENT, MAINTENANCE, AND REPAIR OF CROP HARVESTING MACHINERY

One of Sixteen Modules in the Course Preparing for Entry in
AGRICULTURAL MACHINERY - SERVICE OCCUPATIONS

Module No. 11

The Center for Research and Leadership Development

in Vocational and Technical Education

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M E M O R A N D U M

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ADJUSTMENT, MAINTENANCE, AND REPAIR OF CROP HARVESTING MACHINERY

CONTENTS

ADJUSTMENT, MAINTENANCE, AND REPAIR OF CROP HARVESTING MACHINERY

Major Teaching Objective

To develop (1) an understanding of crop harvesting machines and their parts, and (2) the ability to adjust, repair, and maintain these machines.

Suggested Time Allotments

At school		
Class instruction	48 hours	
Laboratory experience	150 hours	
Total at school		198 hours
Occupational experience		102 hours
Total for module		300 hours

Suggestions for Introducing the Module

Crop harvesting machines are the reapers of the farmer's toil. They are extremely important to him. They must operate properly and efficiently if he is to maximize his profits and minimize his expenses. In relying heavily on these machines to bring in his crop, he is also relying heavily on the service department of the agricultural machinery dealership and its employees to keep these machines functioning properly. In order to keep these machines functional, these employees must know the types and functions of harvesting machines, their relationship to the crop they are designed to harvest, and how to adjust and repair them when they need it.

Diversity in types of machines used to harvest crops in various parts of the country exists. Different features exist on the same machine because of design differences developed by major line agricultural machinery manufacturers. Some harvesting machines are built to different degrees of specialization. Therefore, it was deemed most wise to use the operator's and manufacturer's service manuals as the basic repair and adjustment references. Only those machines used in all parts of the country have been included in this module. The subject matter content presented in each competency provides the necessary background information needed to understand how and why to make these adjustments and repairs. The fact that certain machines have been omitted from this module doesn't mean that they should not be studied. These machines should be studied during training schools held by the manufacturer after the student has been employed.

The following techniques should be used to create interest in the module.

1. Identify machines on farms in the community that are out of adjustment and are in need of repair. Take students on a tour

of these farms and demonstrate the operation of these machines. Have students attempt to identify what part or parts are out of adjustment and how they should be properly adjusted.

2. Place parts from several machines around the classroom and have students attempt to identify them.

3. Using a panel composed of a farmer, agricultural machinery dealership manager, and a mechanic, discuss the importance of proper adjustment and repair of crop harvesting machines.

Competencies to be Developed

I. To understand how to use operator's and service manuals when adjusting, maintaining, and repairing agricultural machinery

Teacher Preparation

Subject Matter Content

If the person being taught this modules on "Adjustment, Maintenance, and Repair of Crop Harvesting Machinery" has not been taught the competency on using operator's and service manuals included in the "Adjustment, Maintenance, and Repair of Tillage, Planting, Spraying, and Fertilizing Machinery," they should be taught that competency at this time.

II. To select and use proper lubricants for agricultural machines

Teacher Preparation

Subject Matter Content

If the person being taught this modules on "Adjustment, Maintenance, and Repair of Crop Harvesting Machinery" has not been taught the competency on understanding agricultural machinery lubrication included in the module on "Agricultural Machinery Assembly and Lubrication," they should be taught that competency at this time.

III. To (1) identify the parts of hay harvesting machines and understand their functions and (2) adjust and repair these machines

Teacher Preparation

Subject Matter Content

An understanding of the operation of hay harvesting machinery is of utmost importance to a farm machinery mechanic and mechanic's

helper. These machines are used in all parts of the country and agricultural machinery service employees will be required to service and repair these machines each year.

The common hay harvesting machines include mowers, hay conditioners, rakes, and balers.

Mowers, in the main, are used to cut native grasses and other hay crops.

There are several types of mowers determined by the manner in which they are attached to the tractor.

1. Trail

2. Integral rear-mounted

3. Side-mounted or central-mounted

The above types of mowers can be further divided according to whether they are of the pitman or pitmanless type of mower.

The pitmanless mower knife is driven by either single or double counterbalance wheels permitting a smoother, faster knife speed. (See reference Farm Machinery and Equipment, pages 293 and 294, for an example of a pitmanless mower.)

The pitman on the pitman type mower is a rigid connecting link between the source of power and the mower knife. It connects rotary motion into straight-line motion. (See reference Machine for Power Farming, pages 237 and 238, for a discussion of the pitman and its function.)

A mower is made up of the following parts:

Part	Function
Frame	That part that supports the drive and cutter bar mechanism
Drag bar	That part that extends from the frame to the yoke
Yoke	The part to which the cutter bar is hinged
Pullbar	That part of the mower that keeps the yoke and cutter bar forward as they drag on the ground

Part	Function
Cutter bar knife	That part which actually cuts the hay
Knife bar	That part of the cutter bar which supports the knife
Knife sectors	The triangle shaped pieces on the knife
Guards	The pointed parts on the cutter bar that parts and guides the hay to the knife sectors
Ledger plate	That part that is riveted to the guard and forms one half of the cutting unit
Wearing plate	That part which supports the rear side of the knife
Knife chips	Those parts that hold the knife sections down close to the ledger plate
Grass hand and stick	Those parts which divide and rake the cut hay away from the cutter bar
Inside and outside shoes	Those parts which support the inner and outer end of the cutter bar when in operation

Several adjustments are common to all mowers. These include:

1. Angle of cut
2. Load or cutter bar adjustment
3. Register
4. Guard alignment
5. Cutter bar tilt

These adjustments should be made according to the specifications set down in the operator's and manufacturer's service manual for the machine needing adjustment.

Hay conditioners prepare hay for storage or feeding by means of crushing, flailing, or crimping.

The three types of conditioners commonly used to prepare or condition hay are:

1. Smooth roll
2. Corrugated roll or crimper
3. Flail type

In the smooth-roll type, the hay is picked up and fed through two rollers where it is completely crushed. The rollers may be either both rubber or one rubber and the other steel.

The corrugated roll or crimper type conditioner is usually equipped with either two malleable iron rolls, tapered flutes that mesh together, or slotted bar rolls. As the hay passes through the rolls, it is crimped at regular intervals but not completely crushed.

On the flail type conditioner the shear bar is removed and the swinging hammers or knives partially chop the hay.

Modern agricultural hay loaders and balers require that the hay be in a loose, fluffy, continuous windrow before these machines are able to carry out their phase of the hay harvesting operation. In many cases the hay is moved into windrows immediately after it has been cut, requiring turning in order for the hay to come out properly. The side-delivery rake was developed to meet these requirements.

Several types of side-delivery rakes are commonly used today. The type of rake is determined by the type of reel construction used on the rake. Reel types are:

1. Cylindrical reel
2. Parallel bar
3. Side-stroke
4. Finger-wheel

Each type of rake given above is discussed in the reference Farm Machinery and Equipment, pages 302-306.

The purpose of the hay baler is to pick up hay from a windrow and compress it into a bale.

Two types of balers used to bale hay are:

1. Pickup automatic self-tying balers which make rectangular bales

2. Pickup automatic baler making round bales

Four processes involved in making a bale with a baler are:

1. Pickup

2. Feeding

3. Compressing

4. Tying

The usual type of pickup mechanism on the baler consists of a drum or cylinder with spring steel teeth. The cylinder rotates in the opposite direction of the motor of the baler, lifting the hay and moving it into the machine.

At least four main methods of feeding the hay into the compressing chamber are commonly used on balers. They are:

1. Auger and packer fingers

2. Spring teeth and feeder arms

3. Auger and feeder head

4. Carrier-roller feed

The feeding mechanism on the baler feeds the hay into the compressing chamber where the hay is pressed into a bale. The compressing mechanism is composed of five parts:

1. Plunger

2. Bale chamber

3. Tension bars or rails

4. Retaining plates

5. Metering wheel

On the rectangular bale, the plunger is a rectangular framework that pushes against the hay as it is fed into the compressing chamber. The plunger has a set of knives along the side of the

plunger that is situated next to the feeding mechanism. These knives shear off the hay as it is fed into the compressing chamber making a neat, smooth bale.

The bale chamber is the long rectangular box into which the plunger forces the hay. The tension bars or rails are located in the chamber and offer resistance to the plunger action making a tight bale.

The retaining plates are located in the compressing chamber just out of reach of the plunger. They prevent the bale from moving back toward the plunger after each compression stroke.

The metering wheel is located on the compressing chamber and has spokes that make contact with the hay. As the hay moves through the compressing chamber, it turns the metering wheel. After making a complete turn, the metering wheel engages the tying mechanism.

The last function performed by the baler before it releases the bale is that of tying the bale. The tying function is described on pages 482 and 484 of Machines for Power Farming and 309-311 of Farm Machinery and Equipment.

On the round baler, the hay is fed into a series of rolling belts. The lower set of belts rotate in the opposite direction from that of the upper series of belts. The hay is turned in a circular motion forming a round bale. After the bale becomes so large, it trips the trip rollers and releases the bale. (See Farm Machinery and Equipment, page 312, for an illustration of how the roller baler operates.)

Suggested Teaching-Learning Activities

1. Have students disassemble each type of hay harvesting machine discussed in the content and learn their parts. Point out to the students the materials used in constructing each part and the function each part plays in the total operation of the machine.

2. Demonstrate proper and improper operation of each of the hay harvesting machines under field conditions.

3. Bring to the class hay harvesting machines that are in need of adjustment and repair of each type discussed in the subject matter content. Follow the procedure below when making the needed adjustments and repairs.

   a. Operate the machine in the field noting any malfunctions in operation.

b. Inspect the machine noting worn and broken parts and parts that are out of line or adjustment.

c. Following the operator's and manufacturer's service manuals, make the necessary repairs and adjustments.

d. Lubricate the machine for field operation.

e. Test the machine in the field and make any adjustments necessary for proper operation.

Suggested Instructional Materials and References

Instructional materials

1. Machines for disassembly

2. Machines for use in demonstrating proper and improper field operation and in need of repair and adjustment

References

1. Machines for Power Farming, pp. 427-491.

2. Farm Machinery and Equipment, pp. 289-315.

3. Operator's manuals

4. Manufacturer's service manuals

Suggested Occupational Experiences

Have students adjust, repair, and lubricate hay harvesting machines at the local agricultural machinery dealership under the supervision of a competent mechanic following the procedure outlined in the teaching-learning activities.

IV. To (1) identify types and parts of forage harvesting machinery and understand their functions and (2) adjust and repair these machines

Teacher Preparation

Subject Matter Content

The primary purpose of forage harvesting machinery is to chop field crops and place the chopped crop in a wagon. Two types

of forage harvesters have been developed to accomplish this purpose.

1. Field chopper

2. Flail chopper

The field chopper is by far the most versatile of the two types. This versatility comes from its ability to be adapted to a variety of crop or forage production methods. For example, a unit has been developed for use in harvesting row crops, a unit for picking up forages in the windrow, etc. (See Farm Machinery and Equipment, page 32, for examples of unit attachments for the forage chopper.)

There are three types of field choppers used by farmers.

1. Tractor-drawn

2. Tractor-mounted

3. Self-propelled

The basic unit of the field chopper is made up of the following parts:

1. Wheels

2. Axle

3. Frame

4. Cutter head

5. Blower

6. Feeding mechanism

This unit is powered through the PTO and the tractor. The power from the PTO shaft is carried to the basic unit through the PTO shaft in the harvester.

Three processes are involved in the operation of the forage harvester.

1. Cutting and feeding

2. Chopping

3. Blowing

The feeding and cutting mechanism will vary according to the type of unit attachment that is being used on the harvester. If a row crop unit is being used, an oscillating sickle is used to sever the plants. The plants are moved back toward the chopping unit. If a broadcast unit attachment is used, a mower-like cutter bar cuts the crop. A reel is used to throw the severed plant against an apron which carries the forage back to an auger. The auger in turn carries the material to the chopping unit. If a windrow pick-up is used, revolving fingers lift the forage from the windrow and move the hay to the auger. The auger in turn moves the forage to the chopping mechanism.

Two principle types of cutter heads are used on forage harvesters.

1. Flywheel

2. Cylinder

The flywheel-type cutter head performs two functions, chopping and blowing. The blower paddles are separate from the cutter knives. As the wheel turns, the knives cut the forage and the blower paddles blow the chopped forage up and out of the blower spout.

The cylinder type of cutter head has knives designed to both cut and blow, however, some require a blower to force the chopped forage out of the harvester. (See Farm Machinery and Equipment, page 322 for an illustration of both types of cutter heads.)

The flail type harvester uses free-swinging chains, hammers, or knives to severe the plants through a beating or cutting action. The chopped hay is drawn into the blower fan and blown through the blower spout into the wagon.

Suggested Teaching-Learning Activities

1. Have students disassemble each type of forage harvesting machines discussed in the content and learn their parts. Point out to the students the materials used in constructing each part and the function each part plays in the total operation of the machine.

2. Demonstrate proper and improper operation of each of the types of forage harvesting machines under field conditions.

3. Bring to the class forage harvesting machines that are in need of adjustment and repair. Follow the procedure below when making the needed adjustments and repairs.

   a. Operate the machine in the field noting any malfunctions in operation.

   b. Inspect the machine noting worn or broken parts and parts that are out of line or adjustment.

   c. Following the operator's and manufacturer's service manuals, make the necessary repairs and adjustments.

   d. Lubricate the machine for field operation.

   e. Test the machine in the field and make any adjustments necessary for proper operation.

Suggested Instructional Materials and References

Instructional materials

1. Machines for disassembly

2. Machines for use in demonstrating proper and improper field operation and the need of repair and adjustment

References

1. Machines for Power Farming, pp. 492-515

2. Farm Machinery and Equipment, pp. 317-328

3. Operator's manuals

4. Manufacturer's service manuals

Suggested Occupational Experiences

Have students adjust, repair, and lubricate forage harvesting machines at the local agricultural machinery dealership under the supervision of a competent mechanic following the procedures outlined in the teaching-learning activities.

V. To (1) identify the parts of grain harvesting machines and understand their functions and (2) adjust and repair these machines

Teacher Preparation

Subject Matter Content

The principal grain harvesting machine in use today is the combine. The combine harvests, threshes, and cleans grain all in one operation.

There are two types of combines in use on farms today.

1. Pull type
2. Self-propelled

The pull type is drawn by a tractor. The smaller pull type combines are powered by the PTO of the tractor, whereas the larger combines are powered by an auxiliary engine mounted on the combine.

Self-propelled combines are powered by industrial-type engines and are operated by one man. They are provided with a gear-shift to give desired field and road speed. The combine is steered by a large steering wheel that turns the rear wheels. The travel and operation of the combine is controlled by a transmission and separator clutch. The cutter bar and platform can be raised or lowered to meet changing field conditions from a lever located on the steering shaft. The wheels are adjusted hydraulically to conform to the slope of the land which keeps the threshing, separating, and cleaning units level insuring proper machine action.

The combine performs the following functions.

1. Cutting the standing grain
2. Feeding the cut grain to the cylinder
3. Threshing the grain from the stalk or stem
4. Separating the grain from the straw
5. Cleaning the grain by removing chaff and other foreign matter
6. Elevating the grain from the combine to the holding bin and from the holding bin to the truck

The cutting mechanism cuts the standing grain. The cutting mechanism consists of two parts.

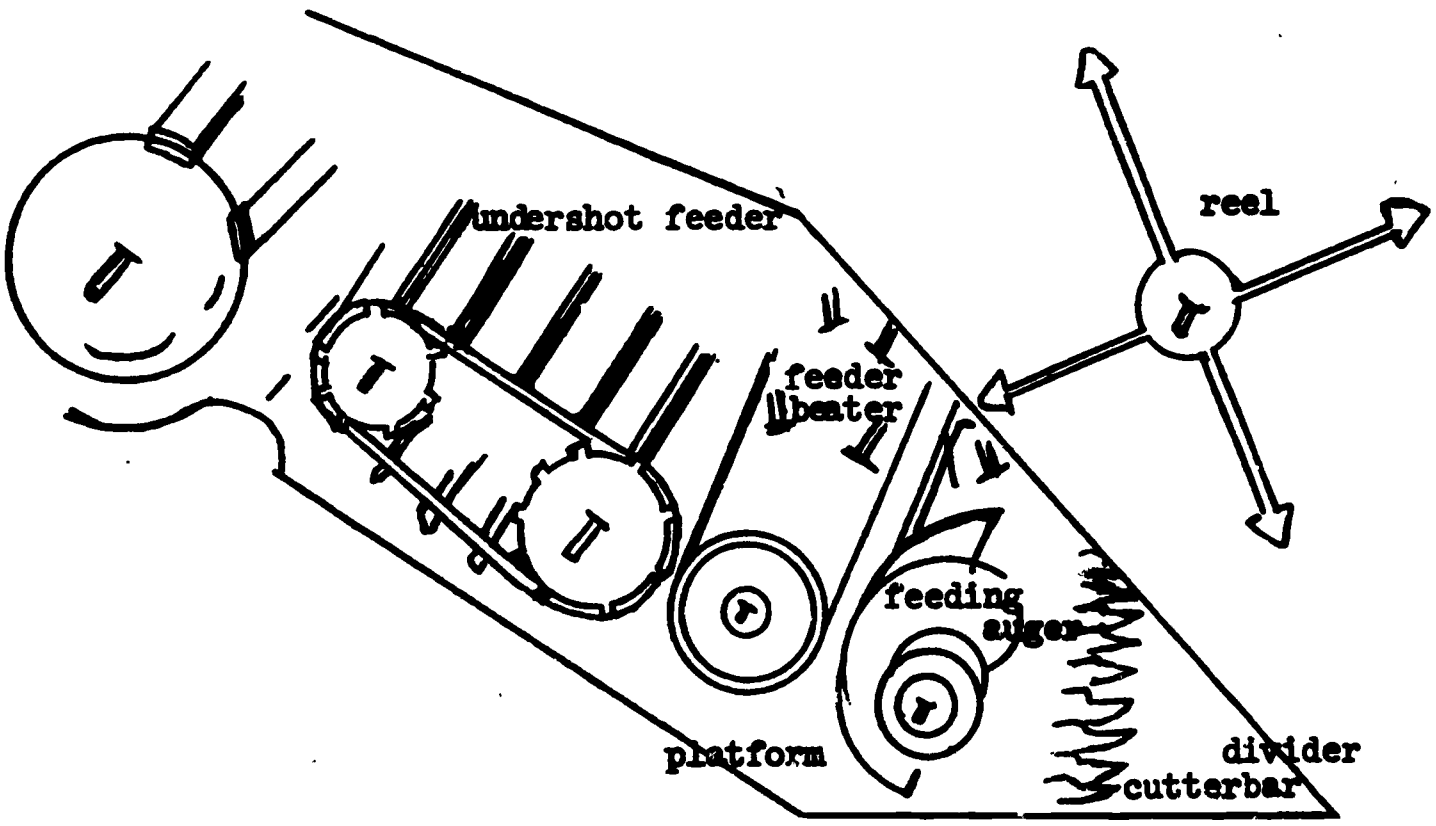
1. Cutter bar

2. Reel

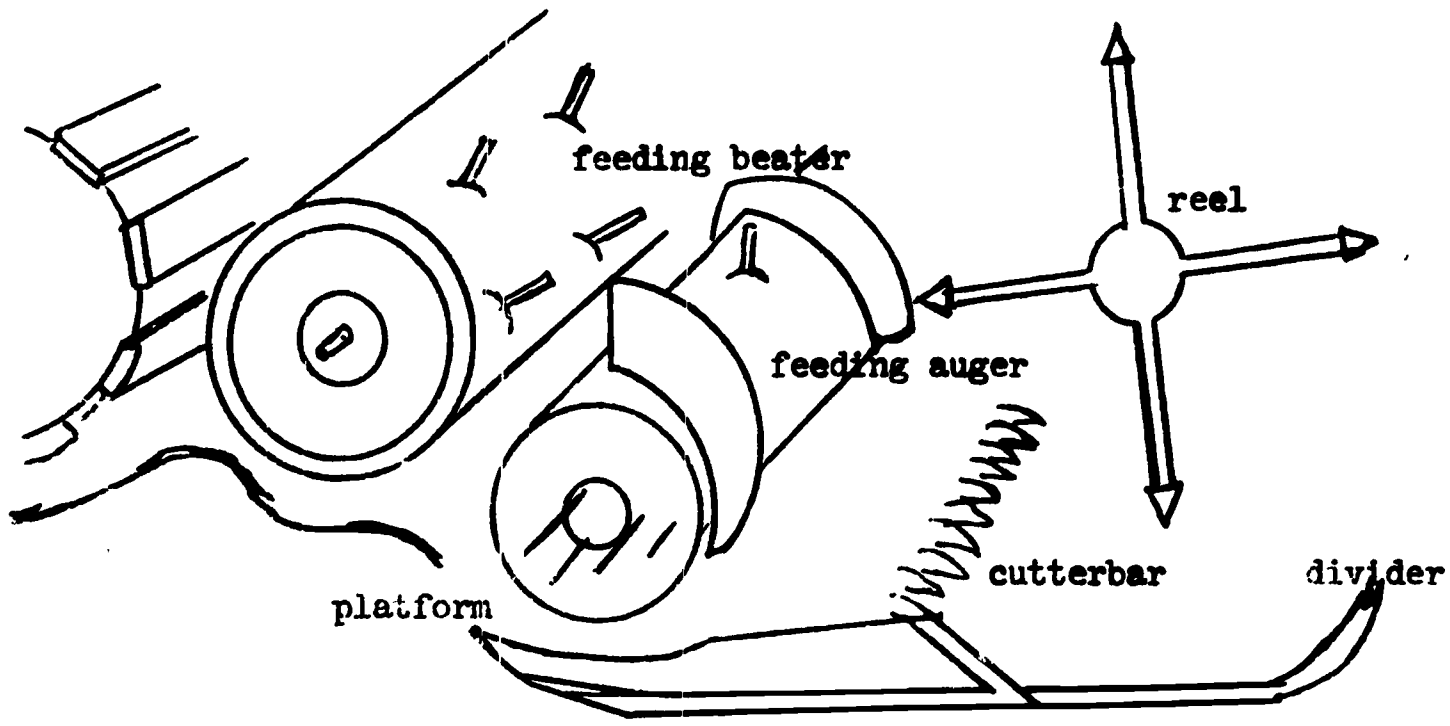
The cutter bar severes the grain heads from the plant and the reel sweeps the heads back onto a canvas or auger table. The knife in the cutter bar extends the full width of the cutter bar and is powered by the rocker arm pitman. The knife sections are serrated.

The reel is located above the cutter bar. It may have as many as six wood bats on the reel to sweep the grain into the elevating platform. It can be adjusted to the height of the crop and on some of the late model machines this adjustment is made through the use of hydraulic cylinders. Common cutting and feeding mechanisms used on combines are illustrated below.

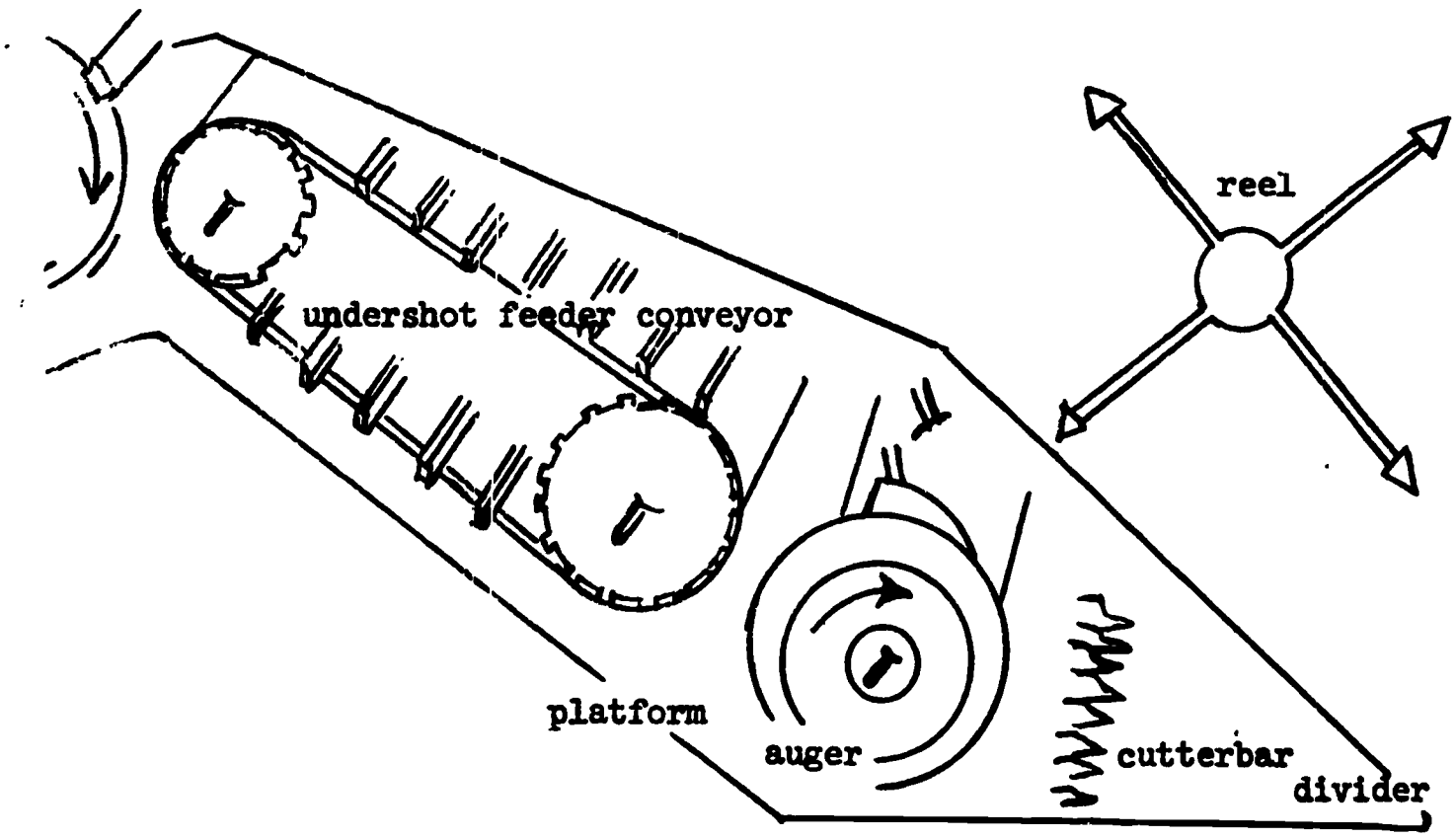
Cutting and feeding mechanism using a feeding auger, feeding beater, and undershot feeder



Cutting and feeding mechanism
using a feeding auger and feeding beater



Cutting and feeding mechanism
using a feeding auger and undershot feeder



The cutting and feeding mechanism is made up of the following main parts:

1. Cutter bar: The cutter bar works like a series of shears running through the field to cut the grain. This is accomplished by knife sections reciprocating (working back and forth) over ledger plates which are held in place by guards. Hold down clamps, wearing plates, and shims are used to keep the knife flat on the ledger plates.

   The sickle bar is usually driven by a pitman drive assembly.

   Power will usually be supplied to the pitman crank by means of a series of belts and chains.

2. Reel: The reel slats gather in the crop, hold it until it has been cut by the knife, and then move it onto the platform. The reel must be square, level, and at the proper height and position to feed the grain uniformly and steadily. The reel may be ground driven or power driven.

3. Platform: The platform holds the cutter bar and feeding mechanisms.

4. Cutting platform auger: The cutting platform auger moves the cut grain to the center of the platform where the retractable auger fingers feed the grain into the feeder conveyor or the feeder beater depending on the design of the combine.

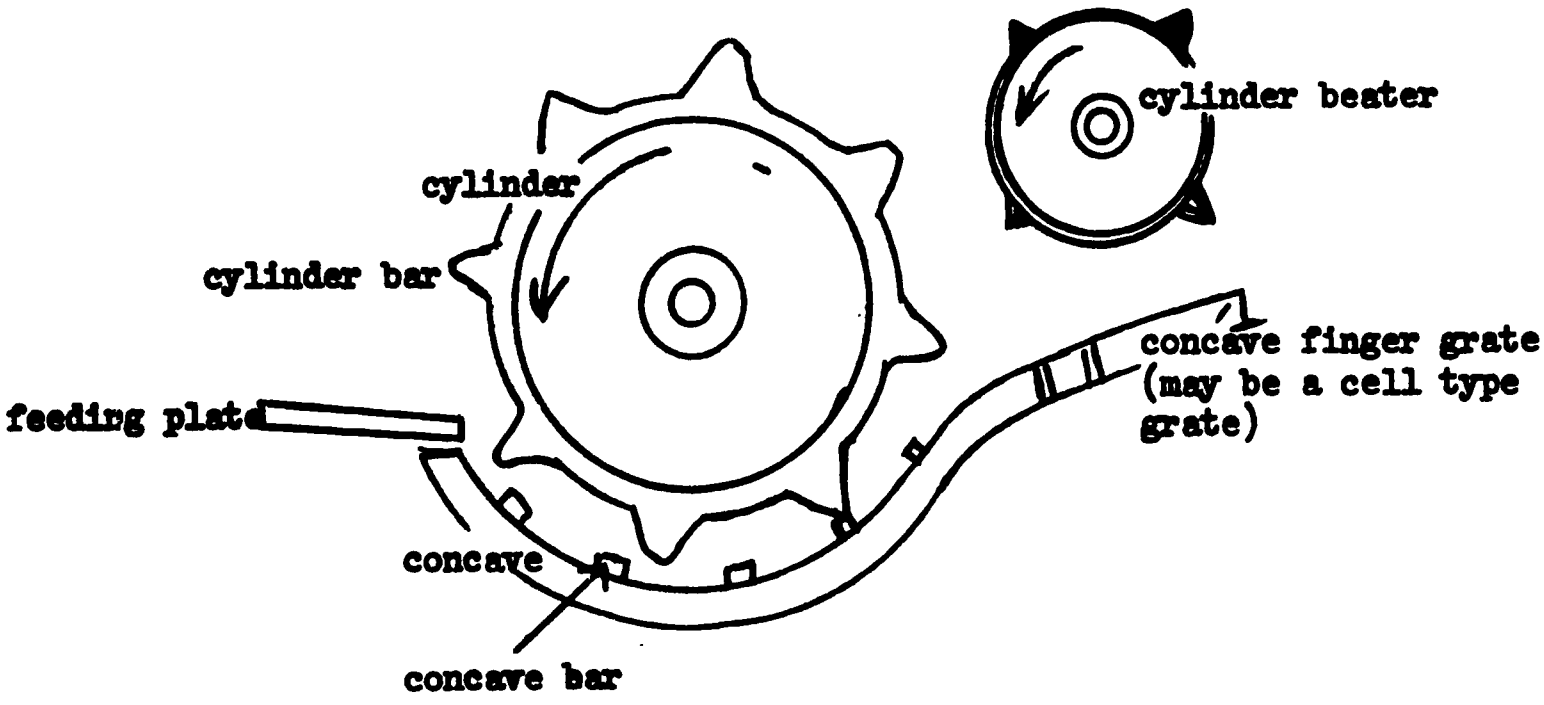
5. Retractable finger feeder beater: In some combines the cutting platform auger is followed by a retractable finger feeder beater which moves the grain into either the feeder conveyor or into the threshing unit.

6. Feeder conveyor: The feed conveyor or feed rake, as it is sometimes called, is designed to feed the grain in a steady even flow into the threshing unit. Proper feeding into the threshing unit will cause less clogging.

7. Feeder beater: Some models of combines will have a feeder beater which takes the grain from the feed conveyor and feeds it uniformly into the threshing unit.

The function of the threshing mechanism of the combine is to thresh the grain from the heads. This is done by passing the grain between a rapidly revolving cylinder and a stationary surface. Underneath is the concave. The rubbing action on the grain caused by the bars on the cylinder passing over the concave channel bars causes the grain to be removed from the head.

Threshing Mechanism



The design of some of the parts shown on this diagram will vary according to the type of combine. Some combines will not have a separate shelling plate and may not have finger grates.

The main parts of the threshing mechanism are:

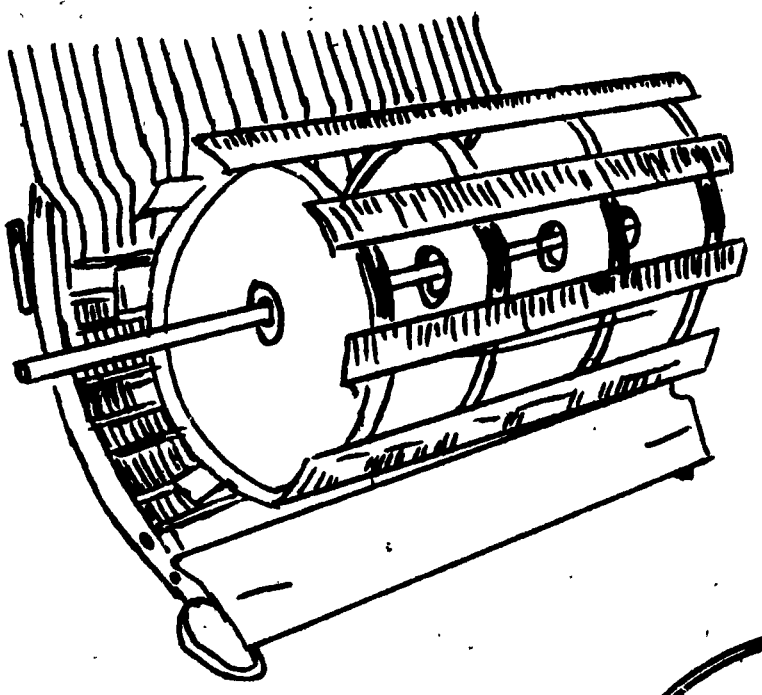
1. Cylinder: The cylinder will have either bars or spikes that will cause the rubbing of the grain against the concave.

    a. Rasp bar cylinder: The cylinder bars are rasp shaped as shown in the illustration.

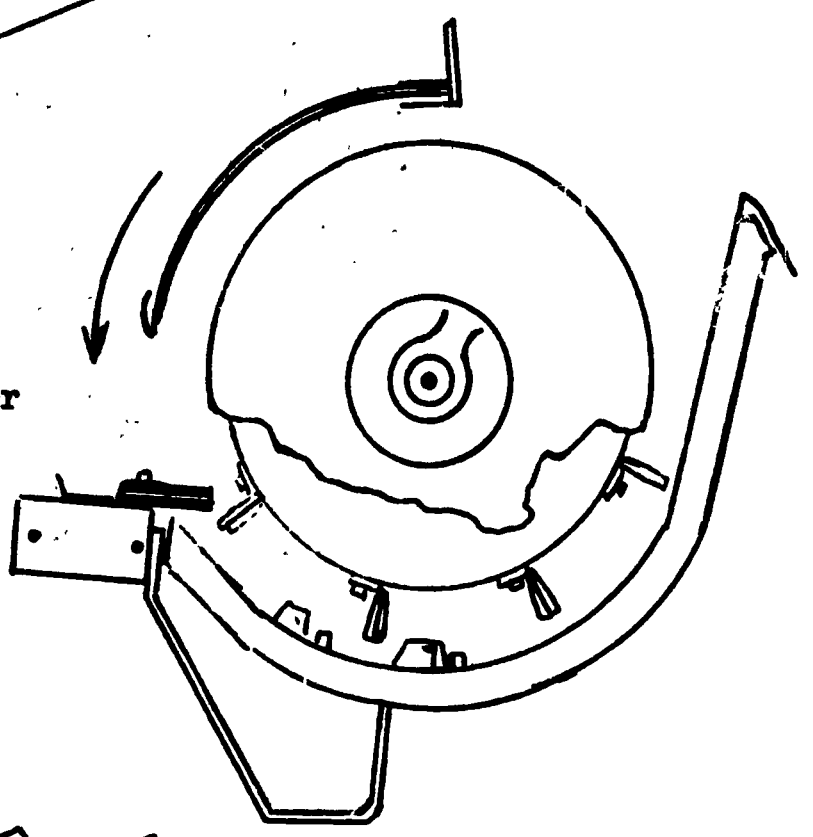
    b. Rub bar cylinder: The cylinder bars are angle shaped and faced with rubber.

    c. Spiked tooth cylinder: The cylinder has spikes instead of bars. This type is not suited for corn harvesting.

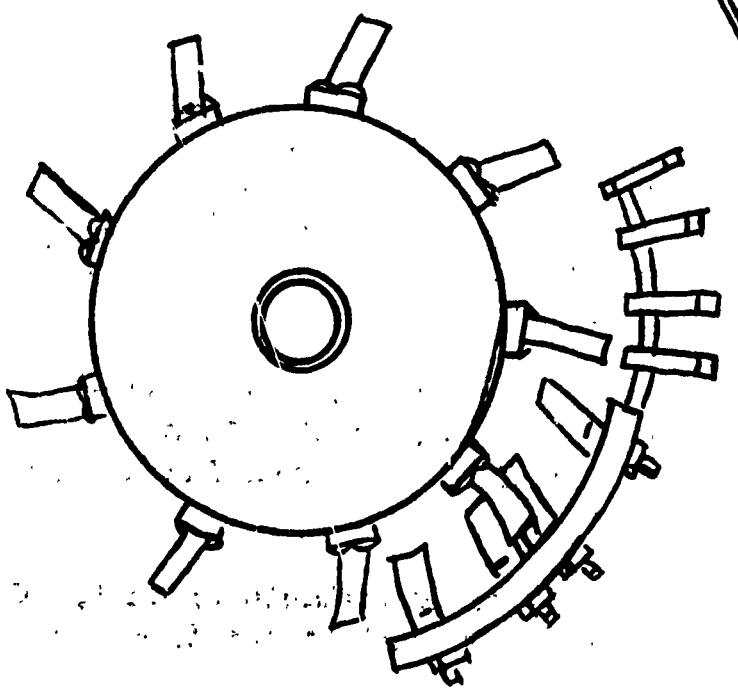
The following diagrams illustrate the types of cylinders mentioned on the preceding page:



Rasp bar cylinder

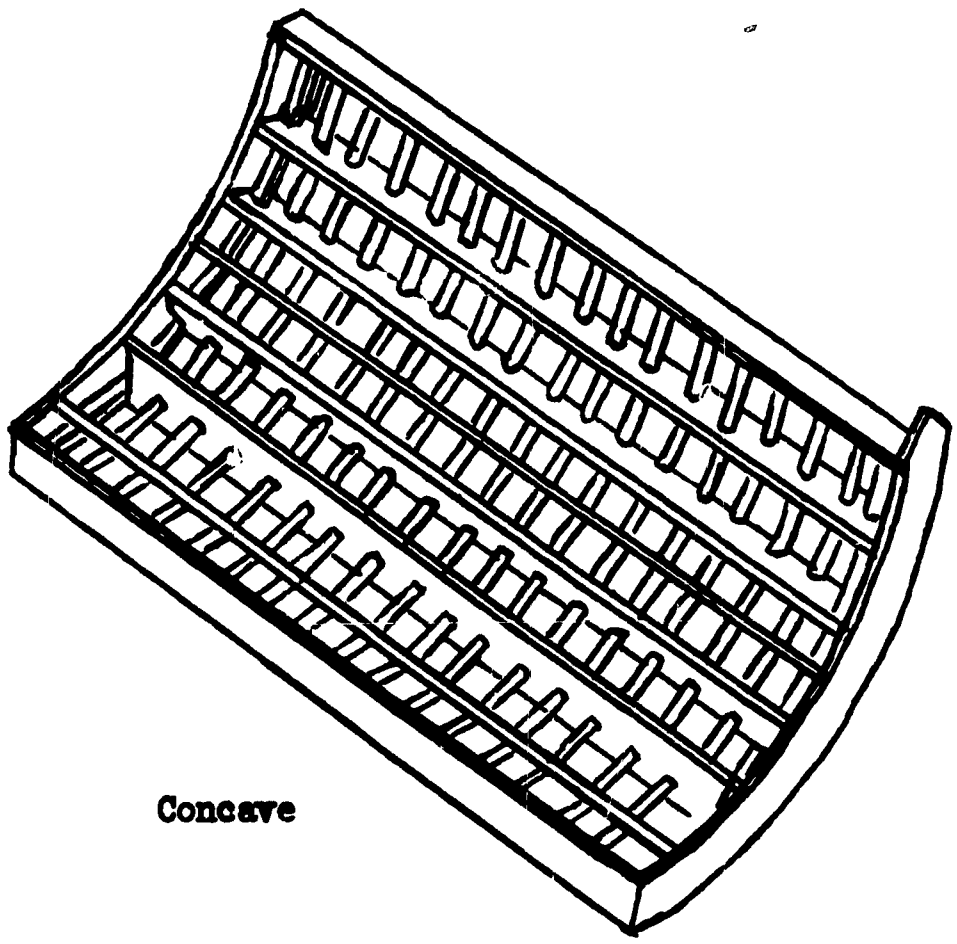


Rub bar cylinder



Spiled tooth cylinder

2. Concave: The concave is the stationary part that the cylinder works against in the threshing action. It is the rubbing action between the cylinder bars and the concave bars that removes the seed from the head or pod. Except for the Allis-Chalmers combine, the concave is a grate composed of rods and bars or wires. It is at the concave grate and finger grate that as much as 90% of the grain is separated from the straw or husk. The separated grain falls through the grate onto the shoe pan where it is delivered to the cleaning unit. The straw and the remaining grain passes on into the separation mechanism.



Concave

3. Cylinder beater: The beater behind the cylinder slows down the material coming from the cylinder, tears apart the straw, and delivers the material to the straw rack or the straw walker as it may be called. The beater helps in cleaning the straw from the cylinder thus preventing cylinder wrapping and feed back.

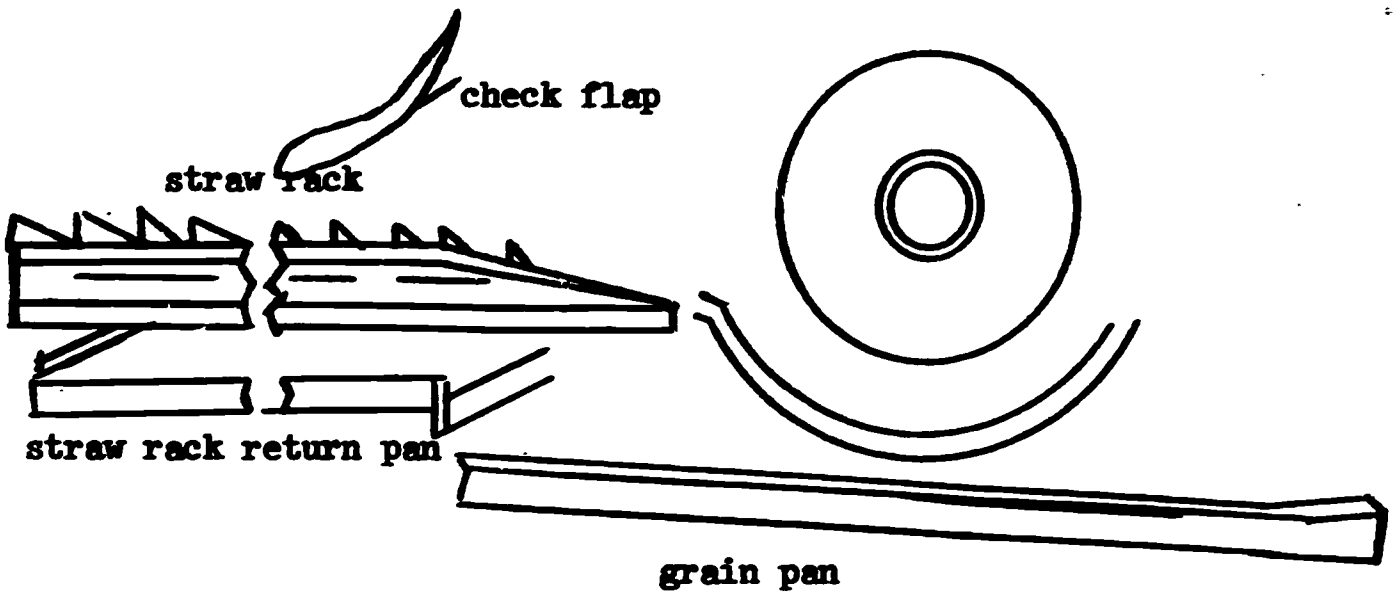
4. Shelling plate: The shelling plate is an adjustable plate located where the cut grain is fed into the cylinder concave unit. Much of the threshing can be done here.

   Some combines will not have an adjustable shelling plate, but will have a feed plate fastened to the front of the concave.

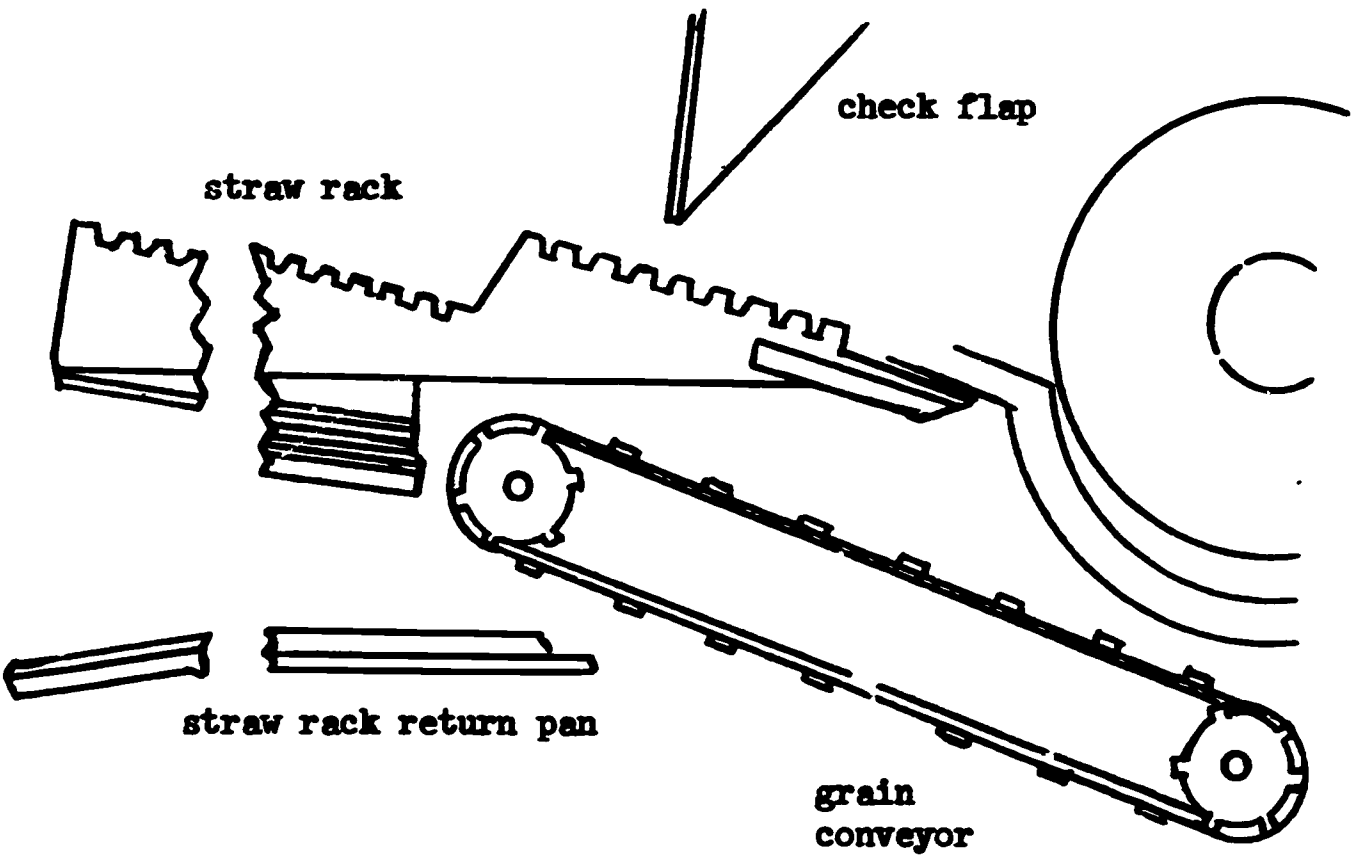
The separating mechanism agitates the straw after it comes from the threshing unit. This shakes out the loose grain remaining in the straw and delivers it to the cleaning unit. Since the threshing unit separated up to 90% of the grain, only about 10% remains to be separated in this unit. The straw is carried out of the combine by the rack.

There are several designs used to collect the grain from the straw rack and concave grate. These are illustrated below.

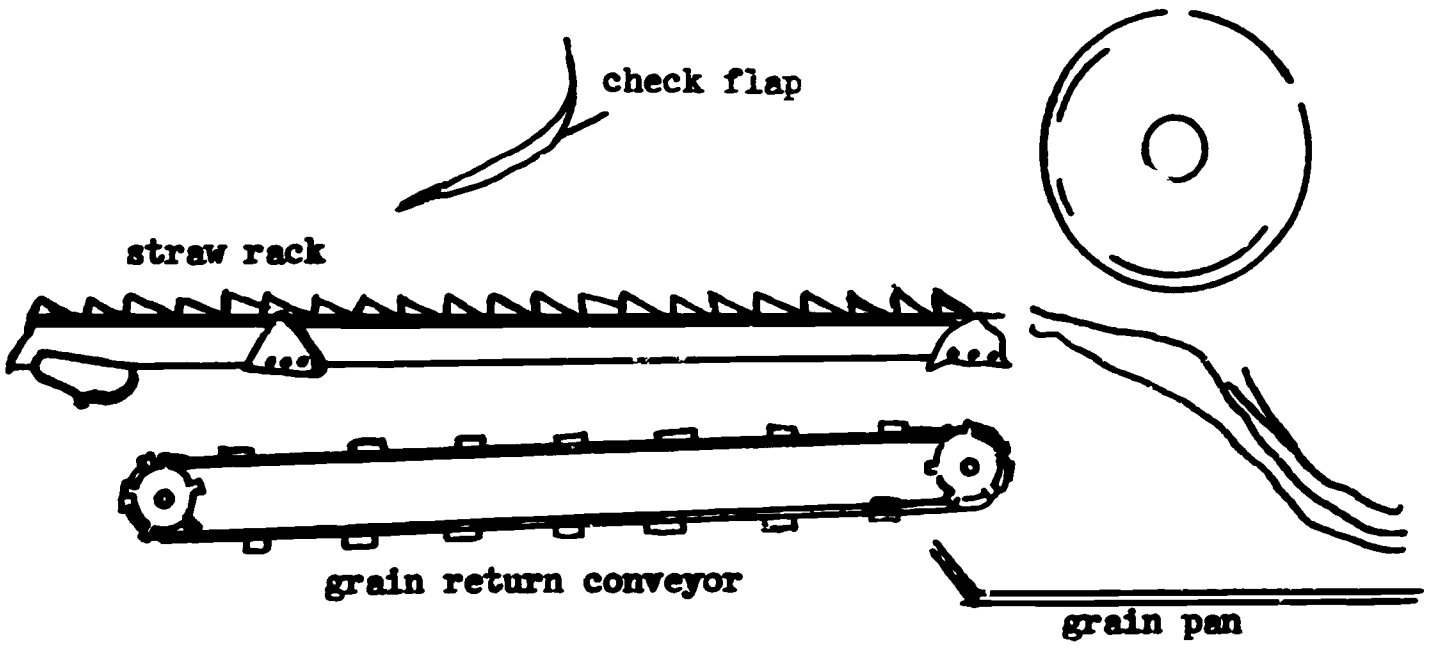
Separating mechanism using straw rack return pan under the straw rack



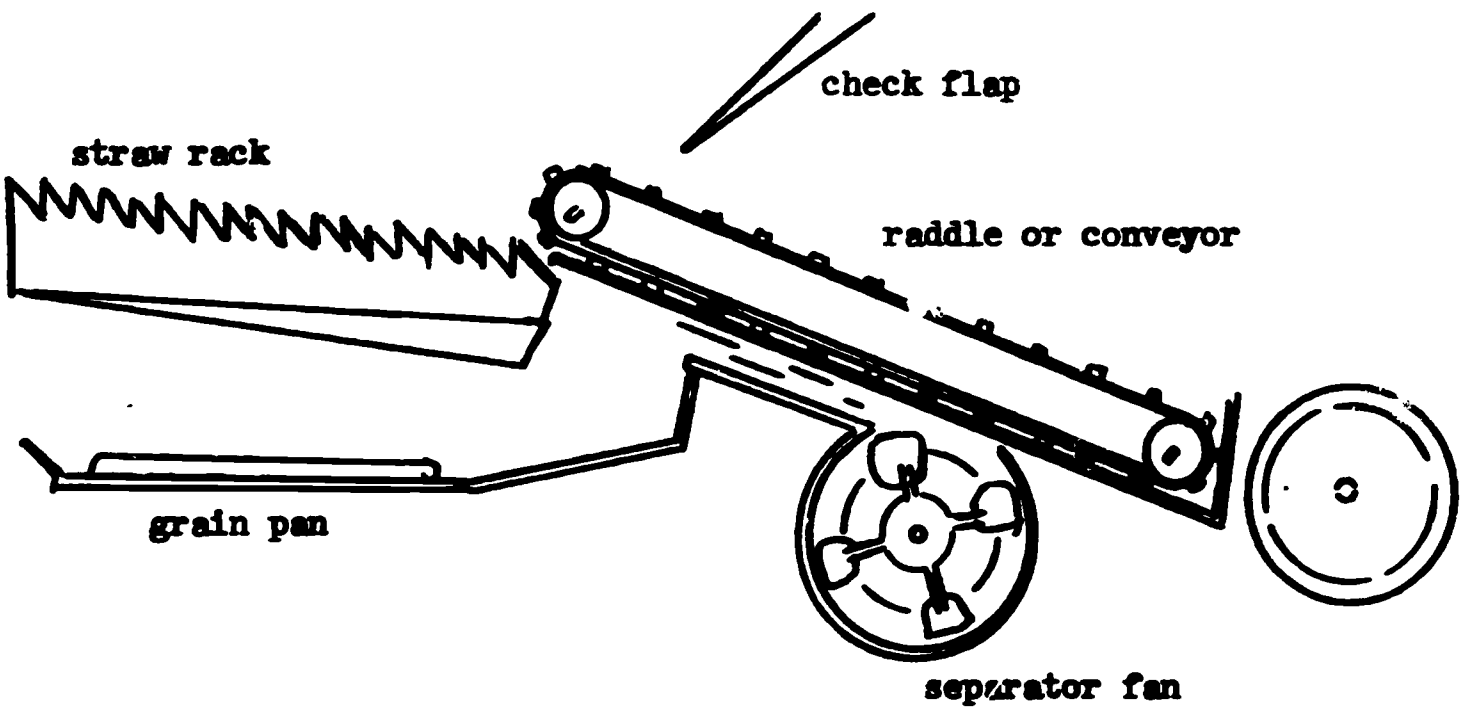
Separating unit using straw rack return pan and grain conveyor



Separating unit which uses a grain return conveyor under the straw rack



Separating mechanism which uses a grain return pan under the straw rack. A cleaning fan is also used in the separating section of this combine.

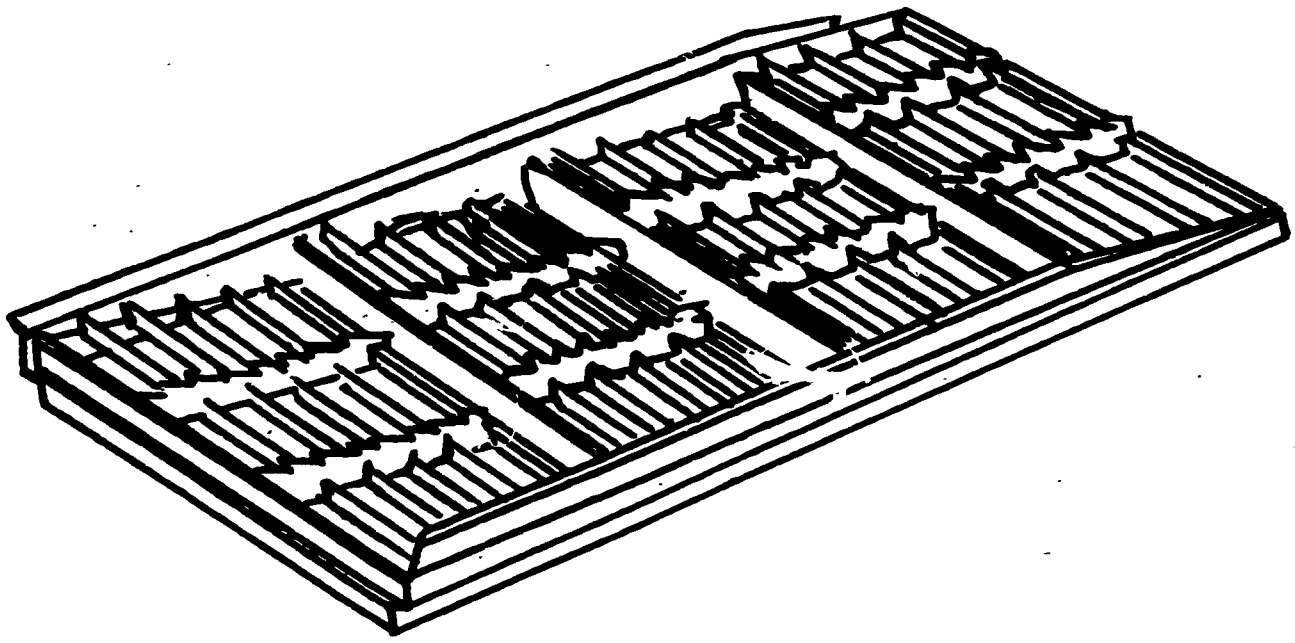


The main parts of the separating mechanism are:

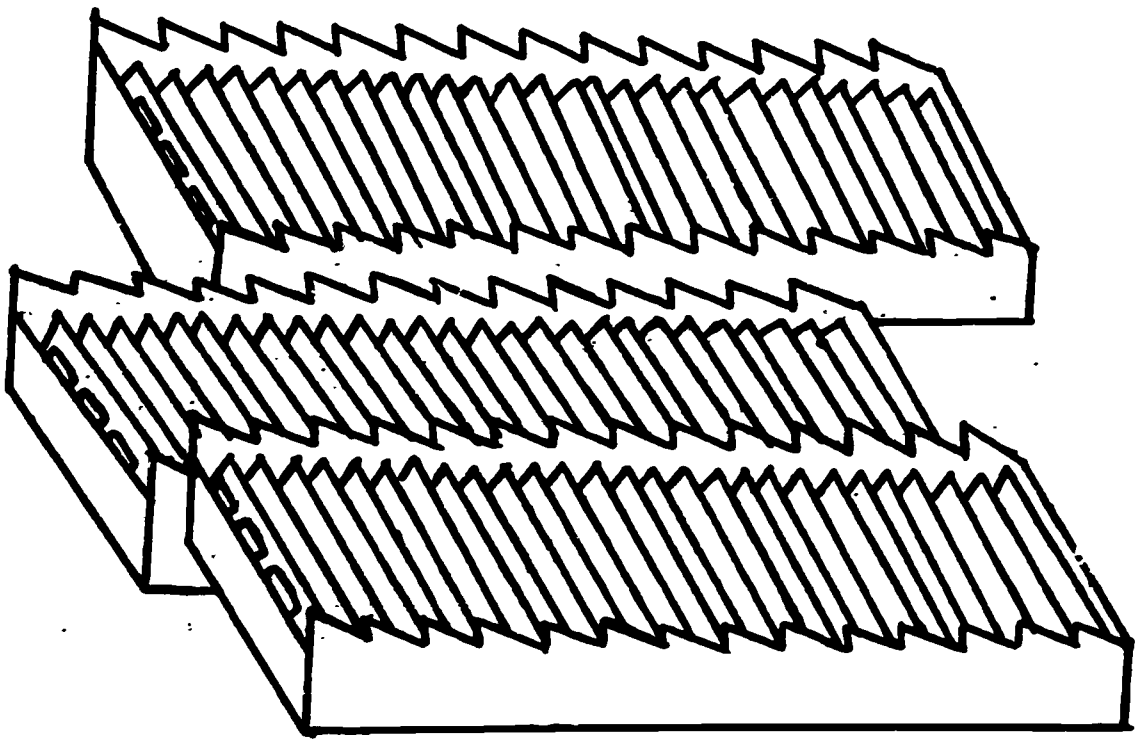
1. Concave grate and finger or cell grate which has been described in the threshing unit.

2. One-piece straw rack: The straw rack is a one-piece unit with risers pointed toward the rear of the combine. The straw rack is mounted on cranks located at the front and rear, which give it an oscillating motion. As the rack moves rearward and upward, the straw is tossed up and to the rear. As the rack returns forward and downward, the straw stays in mid-air for a short time and then falls onto a section of the rack nearer the end of the combine. In this way the straw moves step by step out of the combine. This tossing action causes the grain to be separated from the straw.

One-piece straw rack



Walker type straw rack



3. Walker type straw rack: Some large combines may use a walker type straw rack which operates on the same principle as the rack. The straw walker has three or more narrow sections placed side by side. Each section is mounted on multiple throw cranks located at the front and rear. The crank throws for each section are equally spaced around the circle of rotation; thus, the sections do not operate as a unit as the rack does.

4. Grain return pan: The grain return pan is located under the straw rack. It catches the grain as it falls through the rack and moves forward to the grain pan. The straw walker usually has a return pan under each unit.

5. Grain return conveyor: In place of the grain return pan some combines will use a conveyor to catch the grain and move it forward.

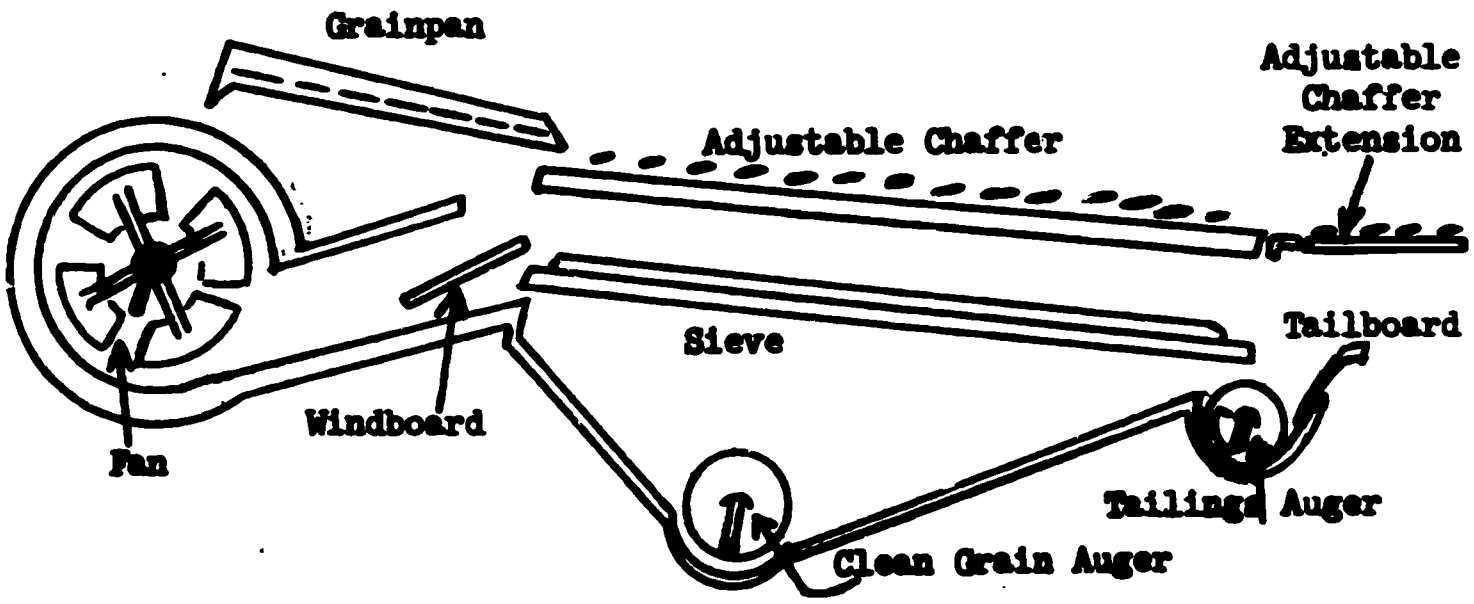
6. Grain pan: The grain pan is usually located under the forward part of the straw rack behind and below the cylinder. Its function is to catch the grain from the concave and cylinder grates and from the grain return pan or conveyor for delivery to the cleaning unit.

7. Grain conveyor: Some combines will use a conveyor in place of the grain pan to collect and deliver grain to the cleaning unit.

8. Check flaps or curtains: The check flaps or curtains deflect the straw and grain onto the rack as the full length of the rack is used for separation. They should not be in the way of the straw as the rack moves it to the rear.

The function of the cleaning mechanism is to separate the clean grain and send it to the grain tank, return the tailings (partially threshed heads) to the cylinder for rethreshing, and move the remaining material out of the combine. This is accomplished by means of gravity and air blast.

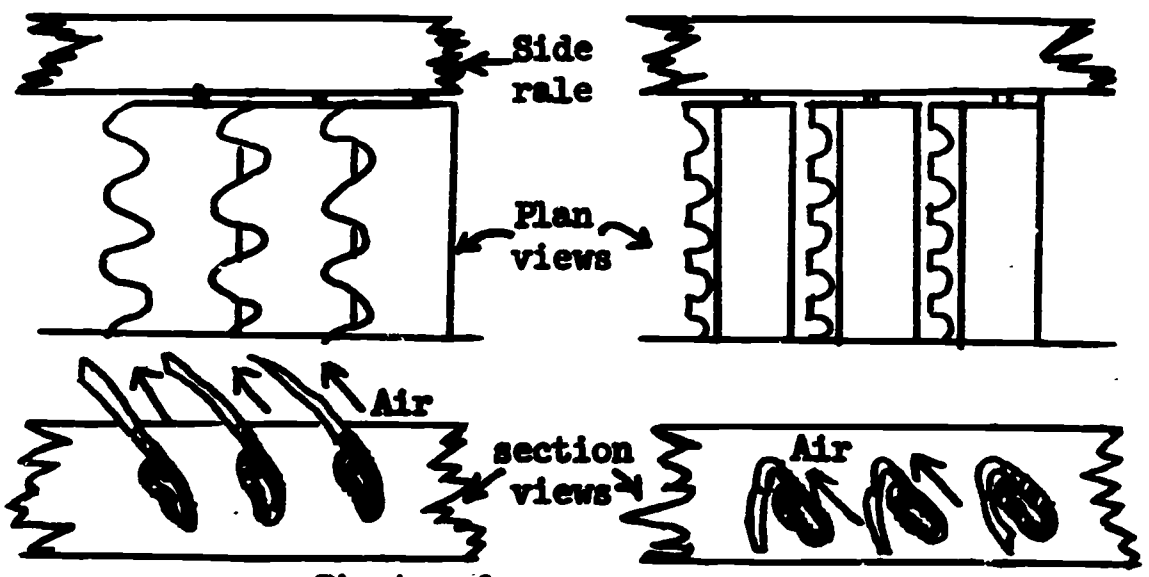
Cleaning unit



1. Adjustable chaffer: The adjustable chaffer acts as a sieve. It is made up of a series of cross pieces mounted on rods and fastened together so they can be moved at the same time to adjust the size of the openirgs.

   Side and flat views of the chaffer showing how the lips may be adjusted to control the amount and kind of materials passing through.

   Partial views of two types of adjustable chaffer sieves



2. Chaffer extension: As the name suggests, this is an extension of the chaffer. In addition to having adjustable lips, the chaffer extension will also swing up and down on the end of the chaffer. The unthreshed portions of grain heads fall through the chaffer extension into the tailings auger and the bulky material passes over the chaffer extension and out of the combine.

3. Sieve: The sieve is like the chaffer except that the lips and openings are smaller. The final job of cleaning is done here. The material that is too large to pass through the sieve is carried over the tailings auger and returned to the cylinder for rethreshing.

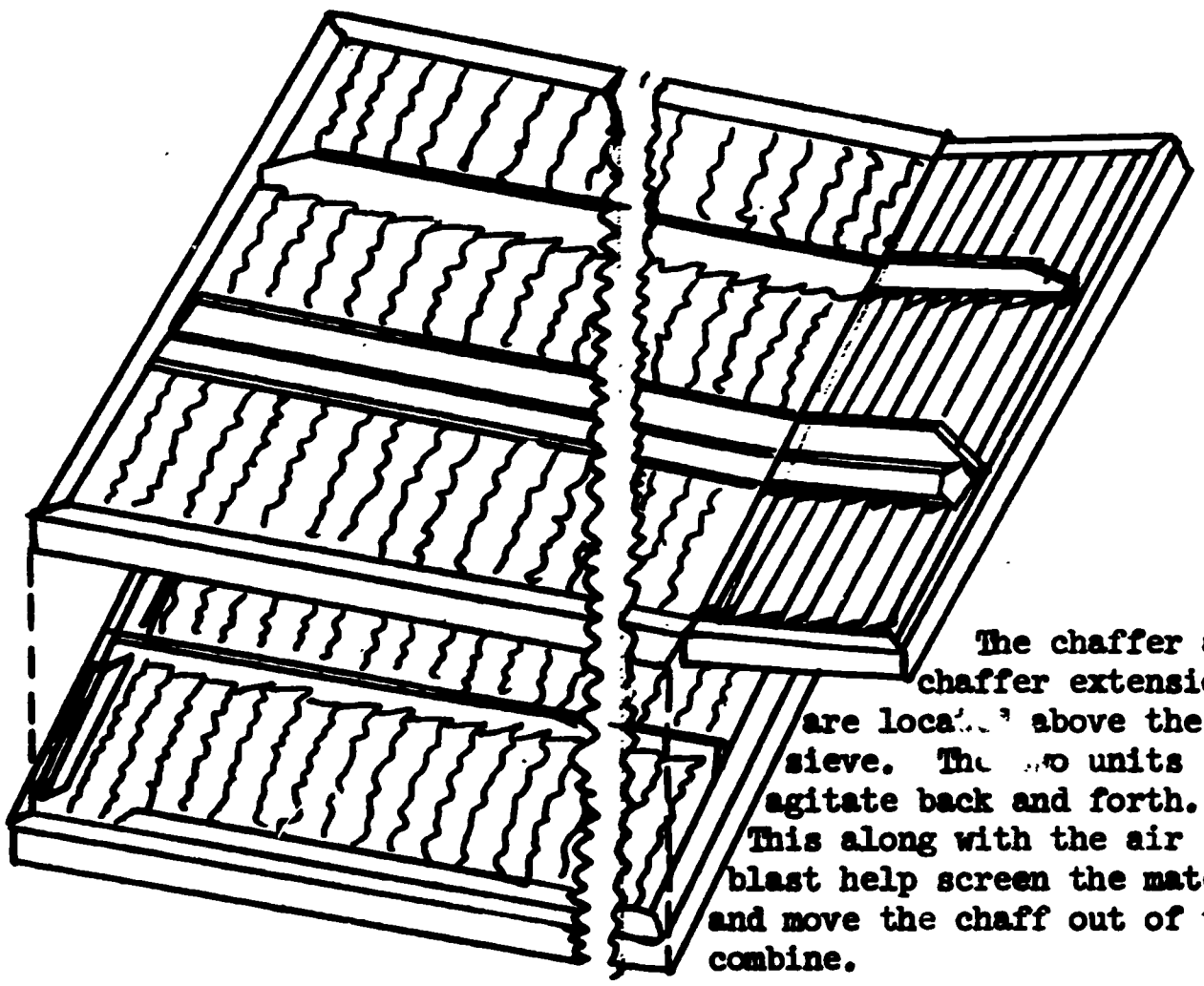
4. Special chaffer and sieve equipment: Many combines will have special screens available for some crops that are difficult to clean.

5. Cleaning fan: The fan furnishes a blast of air. The strength of the air blast is controlled by the speed of the fan and by shutters in the air intake. The direction of the air blast is controlled by windboards. The function of the air blast is to keep the material "alive" on the chaffer and sieve. The air blast should be

strong enough to lift the chaff slightly off the chaffer and sieve, but not strong enough to blow grain out of the combine.

6. Clean grain auger and clean grain elevator: The clean grain auger collects the cleaned grain and augers it to the clean grain elevator which delivers the clean grain to the grain tank.

7. Tailings auger and tailings elevator: The tailings auger collects all of the material which comes off the lower sieve plus any material which falls through the extension chaffer.



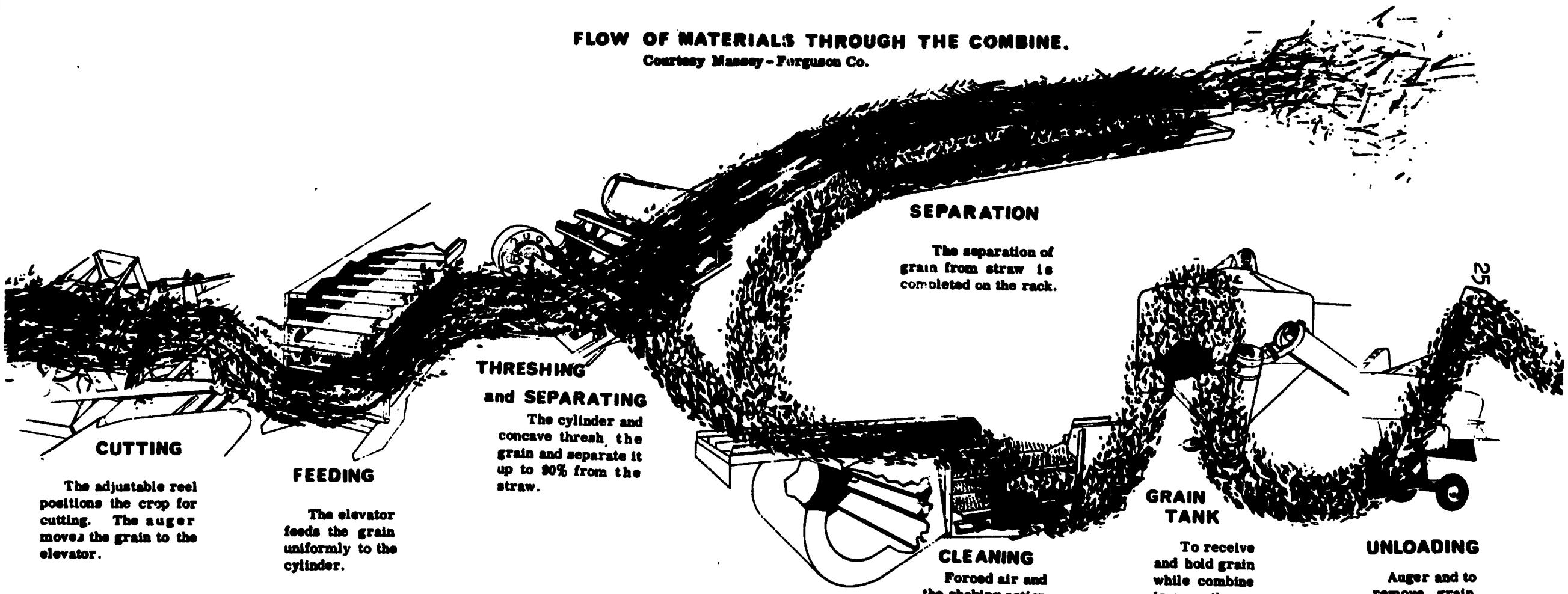
The chaffer and chaffer extension are located above the sieve. The two units agitate back and forth. This along with the air blast help screen the material and move the chaff out of the combine.

8. Tailboard: The tailboard keeps the unthreshed material from being carried out of the rear of the combine while still allowing the chaff to be blown out. It may be raised or lowered as needed.

The following illustrations and description show the operation of the combine and the flow of the grain through it.

FLOW OF MATERIALS THROUGH THE COMBINE.

Courtesy Massey-Ferguson Co.



CUTTING

The adjustable reel positions the crop for cutting. The auger moves the grain to the elevator.

FEEDING

The elevator feeds the grain uniformly to the cylinder.

THRESHING and SEPARATING

The cylinder and concave thresh the grain and separate it up to 90% from the straw.

SEPARATION

The separation of grain from straw is completed on the rack.

CLEANING

Forced air and the shaking action of sieves used to clean the grain.

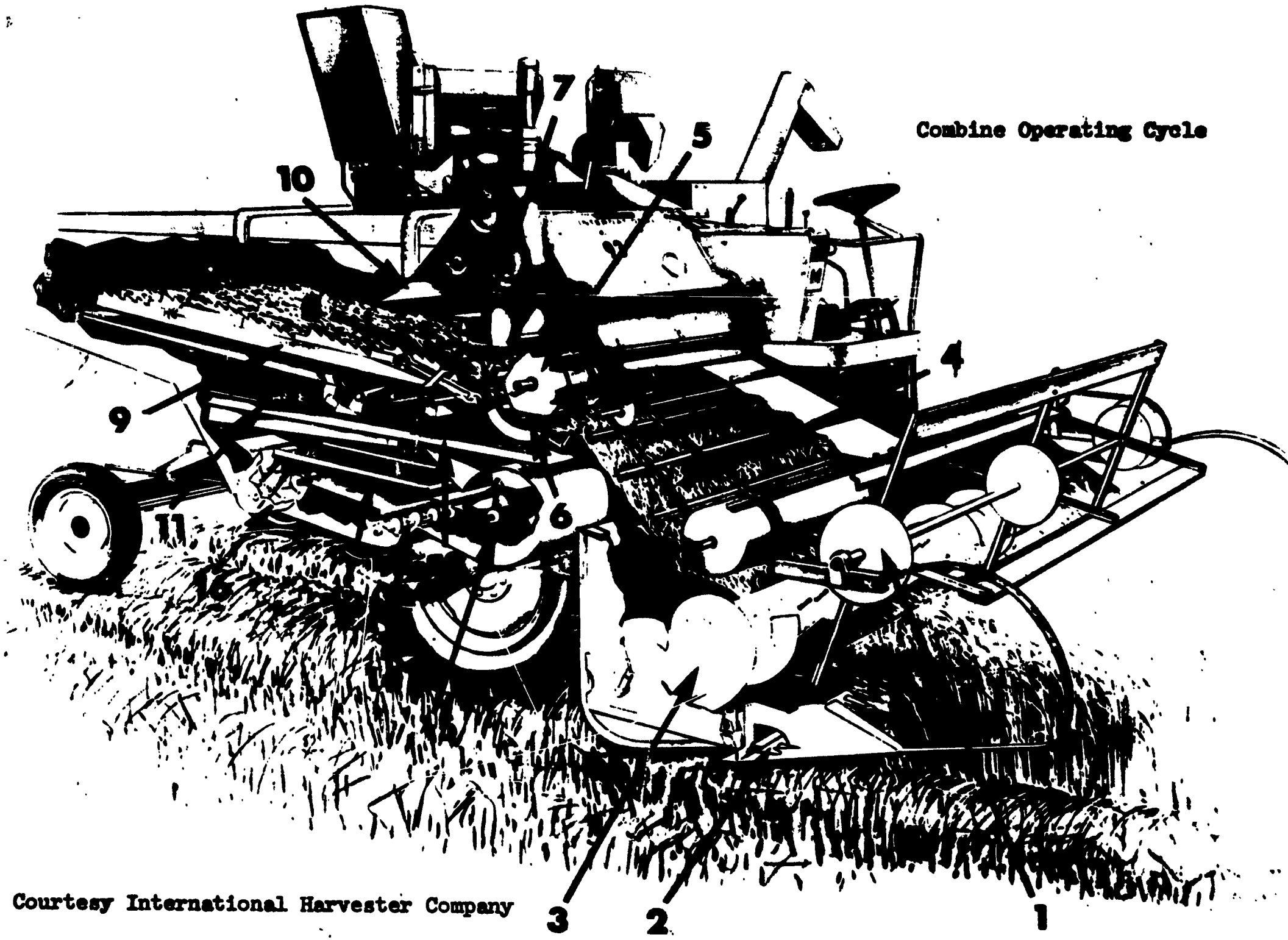
GRAIN TANK

To receive and hold grain while combine is operating.

UNLOADING

Auger and to remove grain from tank.

Combine Operating Cycle

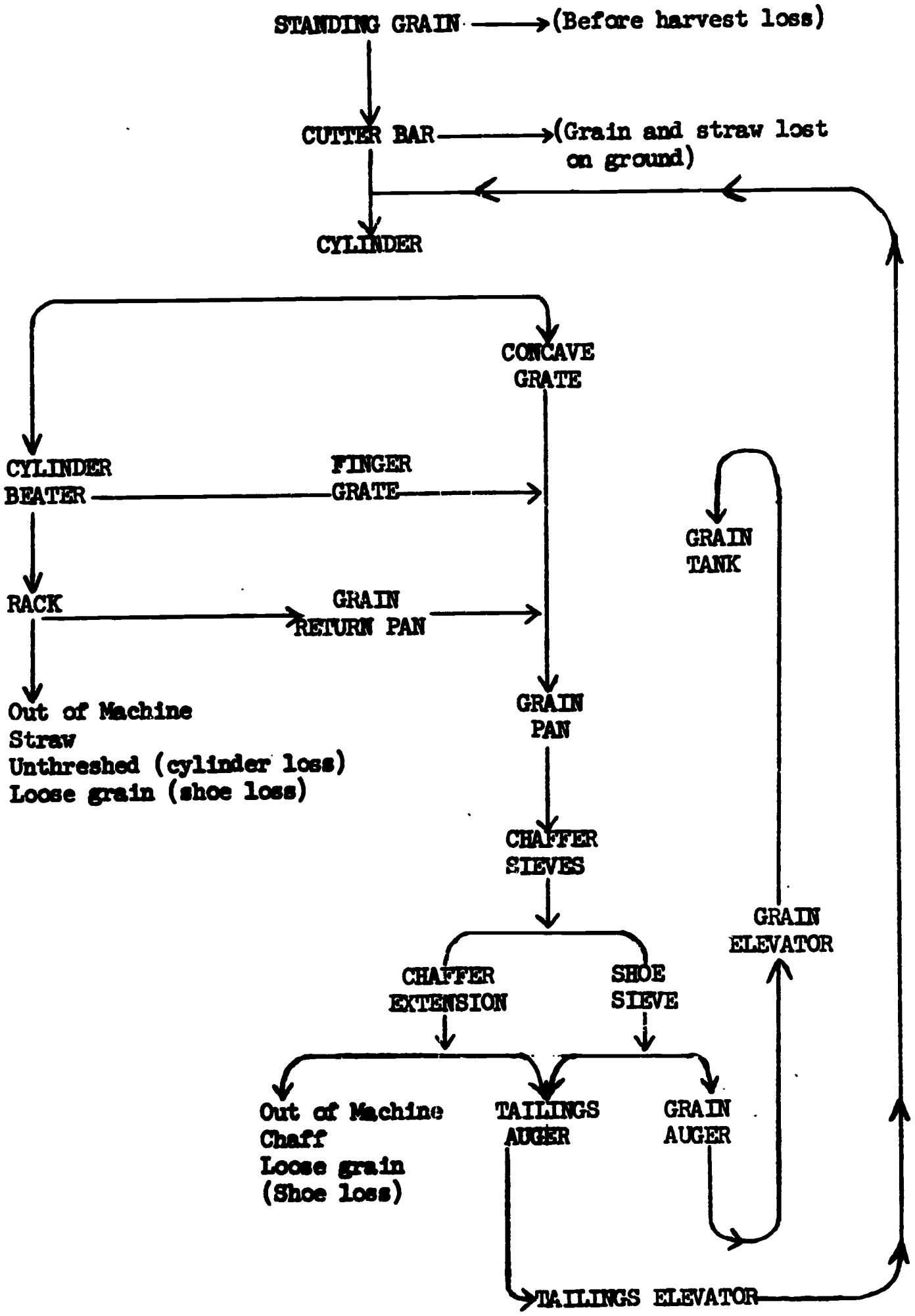


Courtesy International Harvester Company

The Combine Operating Cycle

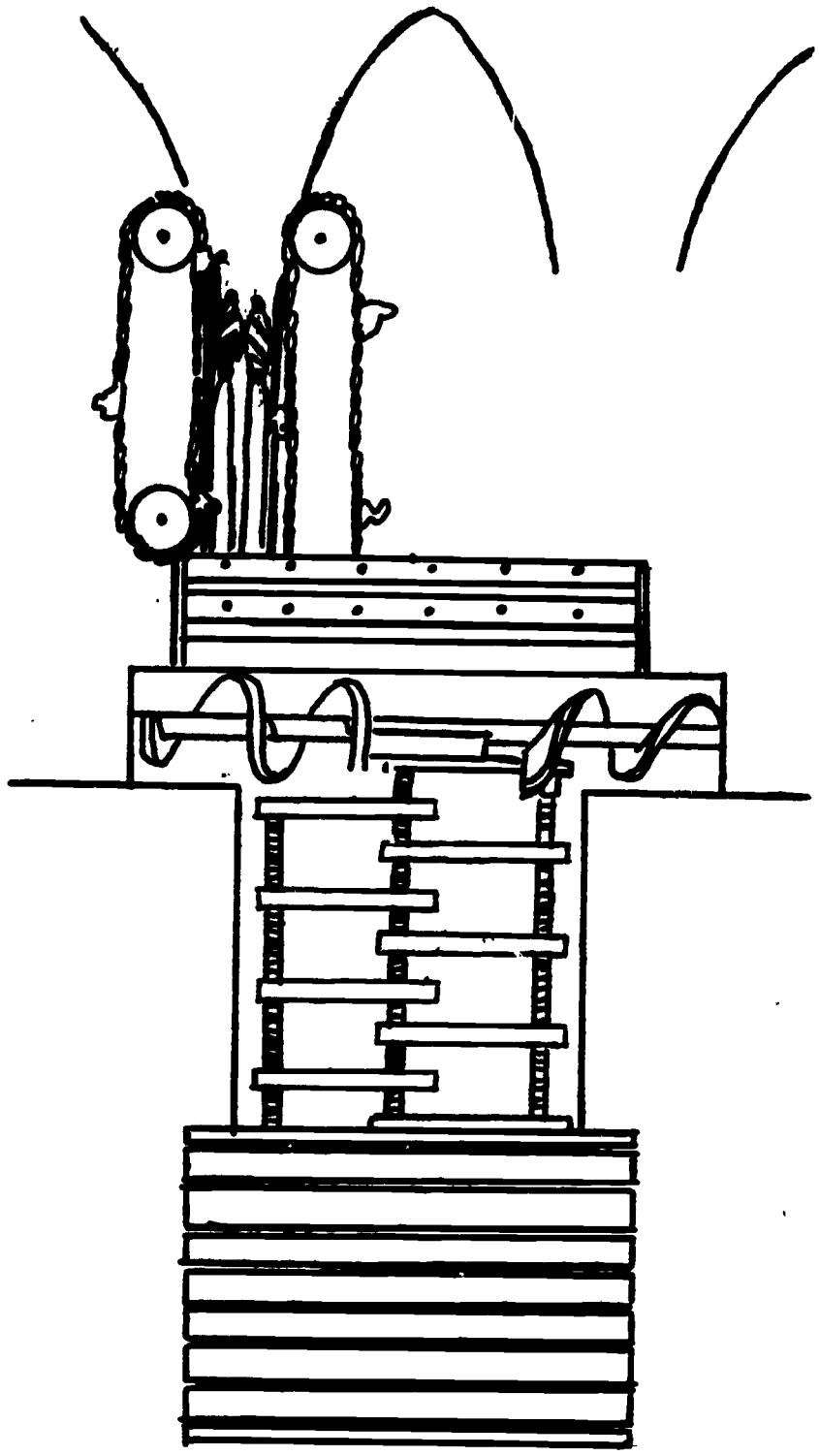
The reel (1) momentarily holds the crop against the guards until the knife (2) cuts the stems, and then it sweeps the cut material onto the platform. The platform auger (3) delivers the cut grain to the feeder (4) which carries the cut grain to the cylinder (5). The grain is rubbed out of the head between the rotating cylinder (5) and the concave grates (6). The cylinder beater (7) strips the cylinder, continues separating loose kernels of grain through the finger grate (8) then moves the material onto the straw rack (9) where final separation takes place. The adjustable cylinder beater check flap (10) regulates the flow of material over the racks. The grain pan (12) catches the grain separated at the concave, cylinder beater grate, and return from the straw racks and delivers it to the chaffer (11). The cleaning fan (15) supplies the wind blast which is the medium of separation. The shoe and sieve (13) operates in the direct opposite to the grain pan and chaffer which assures double action cleaning (as the grain pan and chaffer moves forward, the shoe and shoe sieve move toward the rear.) The shoe sieve (13) is where the final cleaning takes place. The threshed grain falls through the chaffer and shoe sieve, and into the grain trough (14) where it is moved to the grain elevator by the grain auger. The grain elevator conveyor chain then delivers the clean grain to the grain tank. Unthreshed heads will move rearward across the chaffer and shoe sieve and drop into the tailings return auger trough (16). From this point, the unthreshed heads are returned by the tailings elevator to the cylinder for rethreshing.

COMBINE FLOW CHART

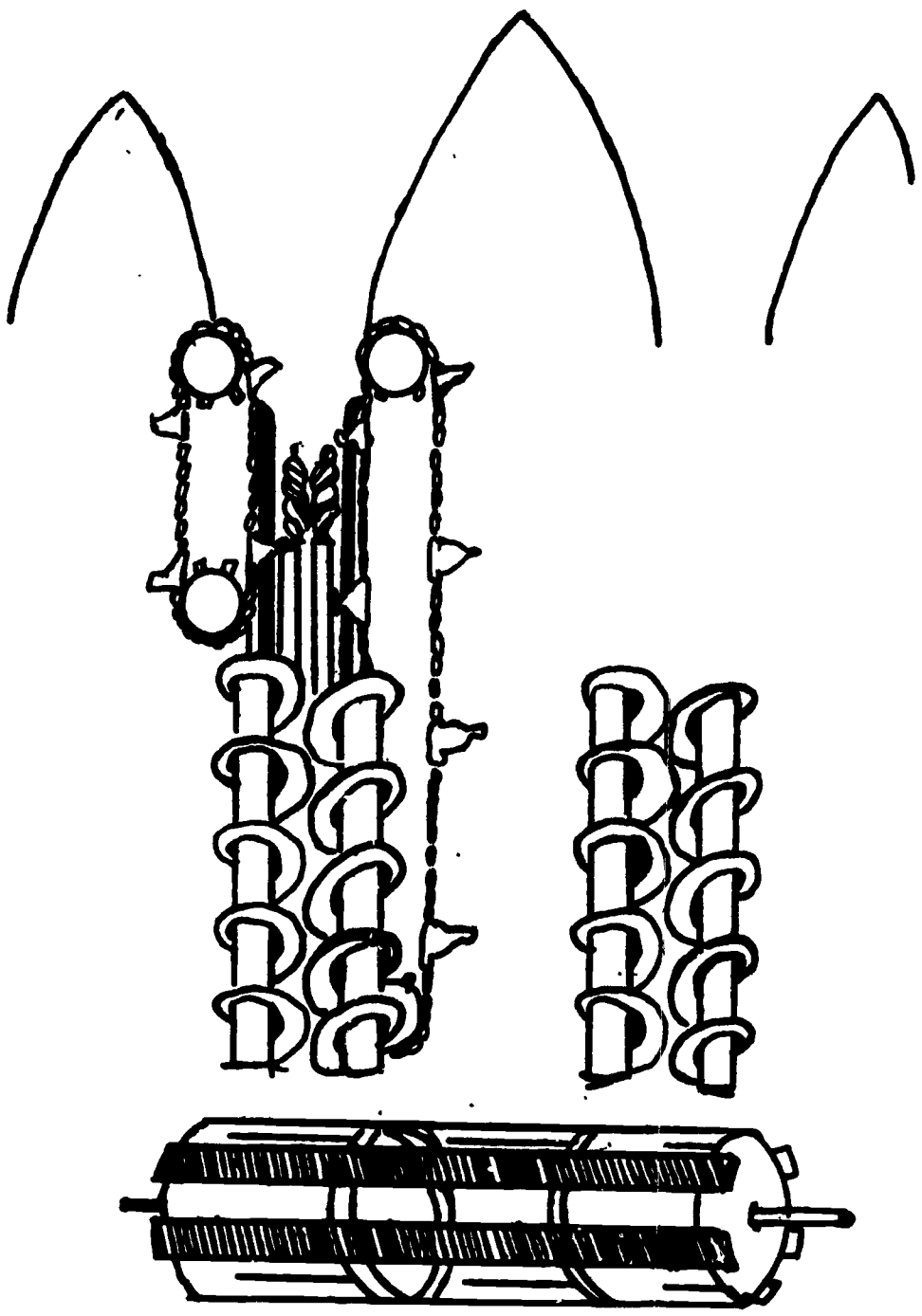


The combine can be converted from small grain to shelled corn harvesting by exchanging the small grain cutting and feeding unit for the corn head attachment.

The corn head snaps the ears from the stalks and feeds them into the cylinder for shelling in the manner illustrated below.

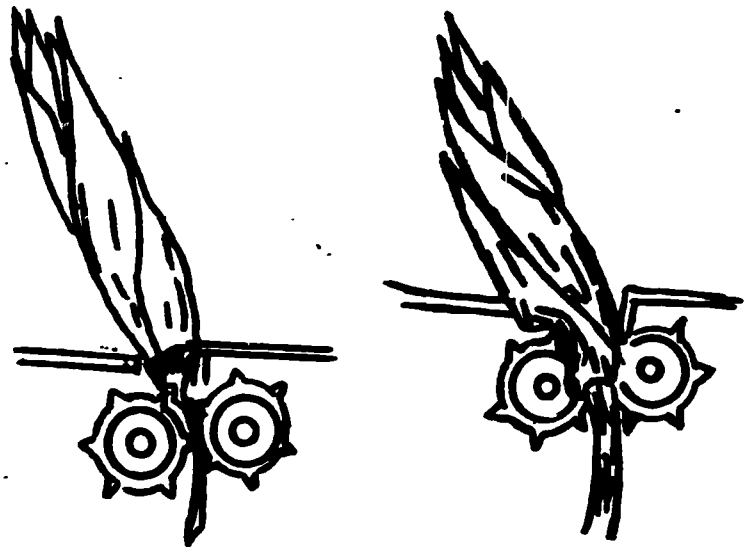


Corn head attachment using a conveyor to feed material into the cylinder



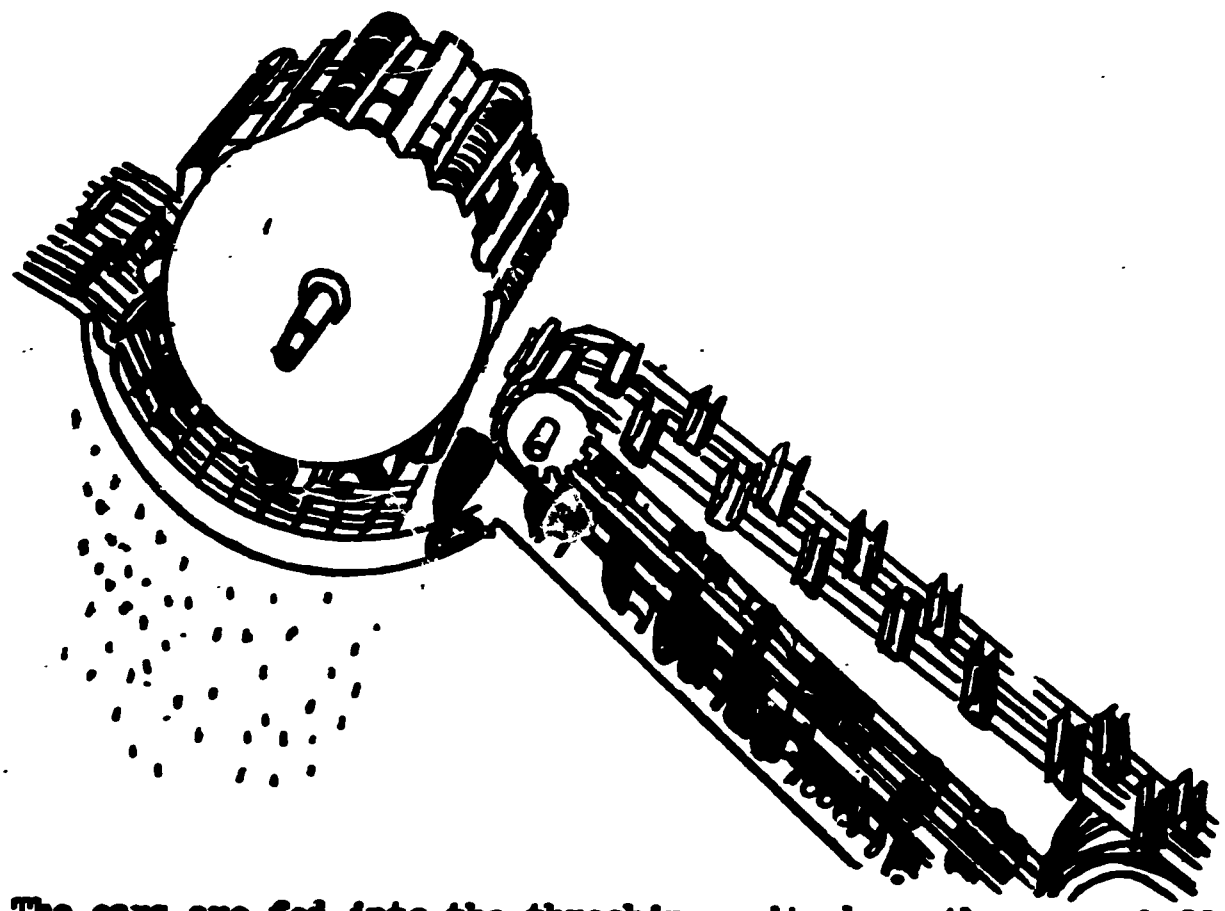
Corn head attachment using augers
to feed material into the cylinder

The corn head operates somewhat differently than the corn picker. The stalks of corn are pulled straight down through the stalk rolls. Snapping bars or stripper plates snap the ears off at the shanks. This action is illustrated on the following page.



Since the ears do not come in contact with the rolls, as in the picker, there is much less shelling in this area.

From the snapping mechanism, the ears are then fed into the cylinder for shelling.



The ears are fed into the threshing unit where they are shelled by the rubbing action of the rotating cylinder against the concave.

A variety of problems are common to all combines. On the following page these problems are identified and possible ways of correcting them are shown.

Courtesy, Massey - Ferguson Limited

Mechanical

PROBLEMS \ SERVICE HINTS / CORRECTIONS	adjust table balance springs	adjust table lift arm	adjust and lubricate drag links	adjust unloader belt	adjust belt clearance at motor pulley	belt not adjusted at transmission pulleys	clean radiator screen and core	check oil level in hydraulic pump	check pump drive belt for non slippage	control arm on speed valve not adjusted	check speed yoke for straightness	check for hydraulic oil leaks	check timing at distributor	check rear tire pressure	check to see that shoe does not hit body	damaged hydraulic lines or fittings	dealer service required	fill fuel tank	fill radiator	keys damaged in vari speed valve	no gear to pump (characteristic)	"O" ring on speed cylinder damaged	recharge battery	refer to operator's manual	remove stalk from sieves	restrictor valve in speed cylinder	spring can on transmission pulley weak	tighten fan belt	turn on ignition switch	turn on fuel at tank		
belt slipping on traction drive					X	X																									
combine not coming to a complete stop					X					X																					
cylinder chain adjustment																								X							
engine overheating						X					X						X											X			
engine will not start											X						X					X						X	X		
gears clash when selecting gears				X				X																							
grain unloading belt slipping			X																												
ground speed uneven						X		X												X		X									
knocking in pump (Bendix)																				X											
machine hard to steer		X									X													X							
machine hard to steer (hydraulic)		X				X	X		X		X		X											X							
sieves being damaged												X												X	X						
table will not lift	X	X				X	X		X				X																		
table will not lower	X	X				X	X						X																		
vari-speed will not move machine						X	X	X	X				X		X											X						

Mechanical Problems Service Hints

Courtesy, Massey - Ferguson Limited

Threshing

PROBLEMS / SERVICE HINTS / CORRECTIONS	adjust auger fingers	adjust concave or cylinder	adjust cylinder cut off bar	adjust cylinder speed	adjust drive belt (flat)	adjust elevator chains	adjust fan mill speed	adjust feeder chain	adjust reel speed	check "key" shaft or drive	adjust sieves	adjust slip clutches	adjust table auger speed	adjust table auger	adjust upper sieve extension	adjust rack speed	adjust rack drive belt	adjust windboards	check curtain in body	check for plugged concave	check space between walkers	check front beater speed	close shutters on fan mill	crop too green	ground speed too fast	install filler plates	knife not centering	knife sections need replacing	ledger plates dull	machine running too slow
back feeding		X	X	X	X		X		X							X	X					X							
cracked grain		X		X		X																							
cylinder plugging		X	X	X																									
excess chaff				X			X			X	X																		
excess gleanings		X		X			X			X	X				X			X											
elevator to cylinder plugging			X					X				X	X																
elevators stopping						X					X														X				
grain bunching in front of auger	X											X	X												X				
loss of grain over shoe		X		X	X		X			X	X																		
loss of grass seed over shoe		X		X	X		X			X	X													X		X	X		
loss from table	X				X			X				X																	
loss over walkers		X		X												X		X						X					
overthreshing		X		X																									
ragged stubble																											X		X	X
straw gathers on windscreen	X							X				X																	
straw spreader spreads unevenly									X								X												
unthreshed heads		X		X																							X		

Threshing Problems Service Hints

Suggested Teaching-Learning Activities

1. Bring a combine before the class disassembled to the point where all the movable parts can be seen, but yet, still functional. Demonstrate the operation of these parts before the class.

2. Have students disassemble a combine completely and learn its parts and their functions.

3. Demonstrate proper and improper combine operation under field conditions.

4. Bring to the class several combines of different makes that are in need of adjustment and repair. Follow the procedure below when making the needed adjustments and repairs.

    a. Operate the machine in the field noting any malfunctions in operation.

    b. Inspect the machine noting worn and broken parts and parts that are out of line or adjustment.

    c. Following the operator's and manufacturer's service manual, make the necessary repairs and adjustments.

    d. Lubricate the machine for field operation.

    e. Test the machine in the field and make any adjustments necessary for proper operation.

Suggested Instructional Materials and References

Instructional materials

1. A combine for complete disassembly

2. Machines for use in demonstrating proper and improper field operation

References

1. Machines for Power Learning, pp. 517-539.

2. Farm Machinery and Equipment, pp. 329-341,

3. Combines and Combining, pp. 1-77.

4. Operator's manuals

5. Manufacturer's service manuals

VI. To (1) identify types and parts of corn harvesting machines and understand their functions and (2) adjust and repair these machines

Teacher Preparation

Subject Matter Content

The purpose of corn harvesting machines is to remove the corn ears from the standing stalks.

Three kinds of machines have been developed to perform this function.

1. Corn snapper
2. Corn picker
3. Corn picker-sheller

The corn snapper is the simplest machine in that it only snaps the ears from the stalk, but does not remove the husks from around the ears. The corn picker is the most commonly used corn harvesting machine. It snaps the ear from the stalk and removes the husks from the ears. The fairly new corn harvesting machine is the picker-sheller. It performs both the snapping and husking activities and, in addition, shells the corn.

The types of pickers are classified by the way they receive power.

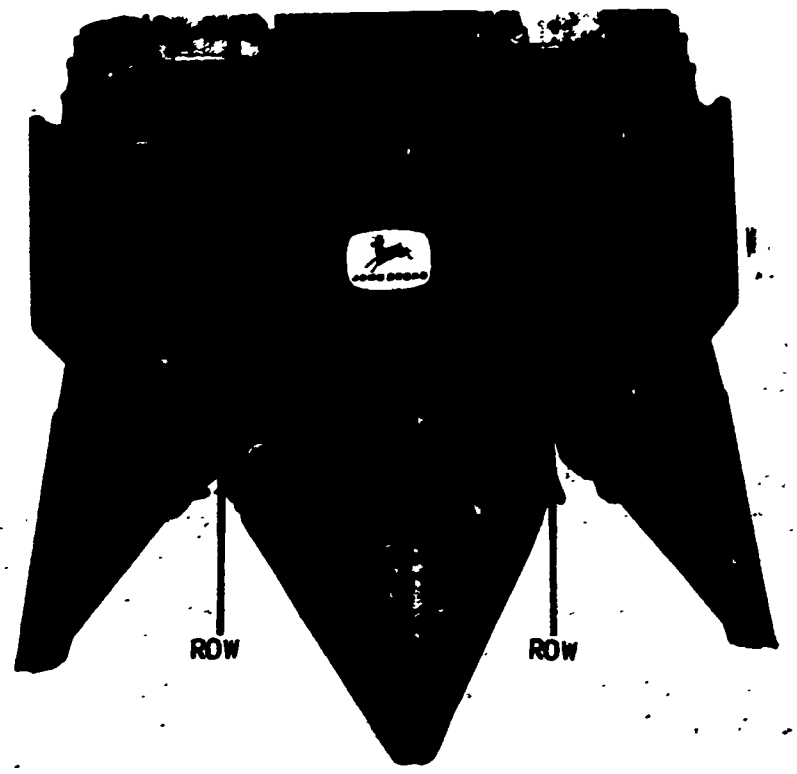
1. Pull-type -- tractor-drawn and driven by the PTO
2. Mounted-tractor -- mounted and driven by the PTO
3. Self-propelled -- driven by its own source of power

The corn picker is composed of several mechanisms that perform specific functions.

1. Gathering mechanism
2. Snapping mechanism
3. Husking mechanism
4. Cleaning mechanism
5. Shelling mechanism

The purpose of the gathering mechanism is to gather and guide the corn stalks into the snapping rolls. The gathering mechanism is made up of the following parts.

1. Points
2. Gathering chains
3. Dividers

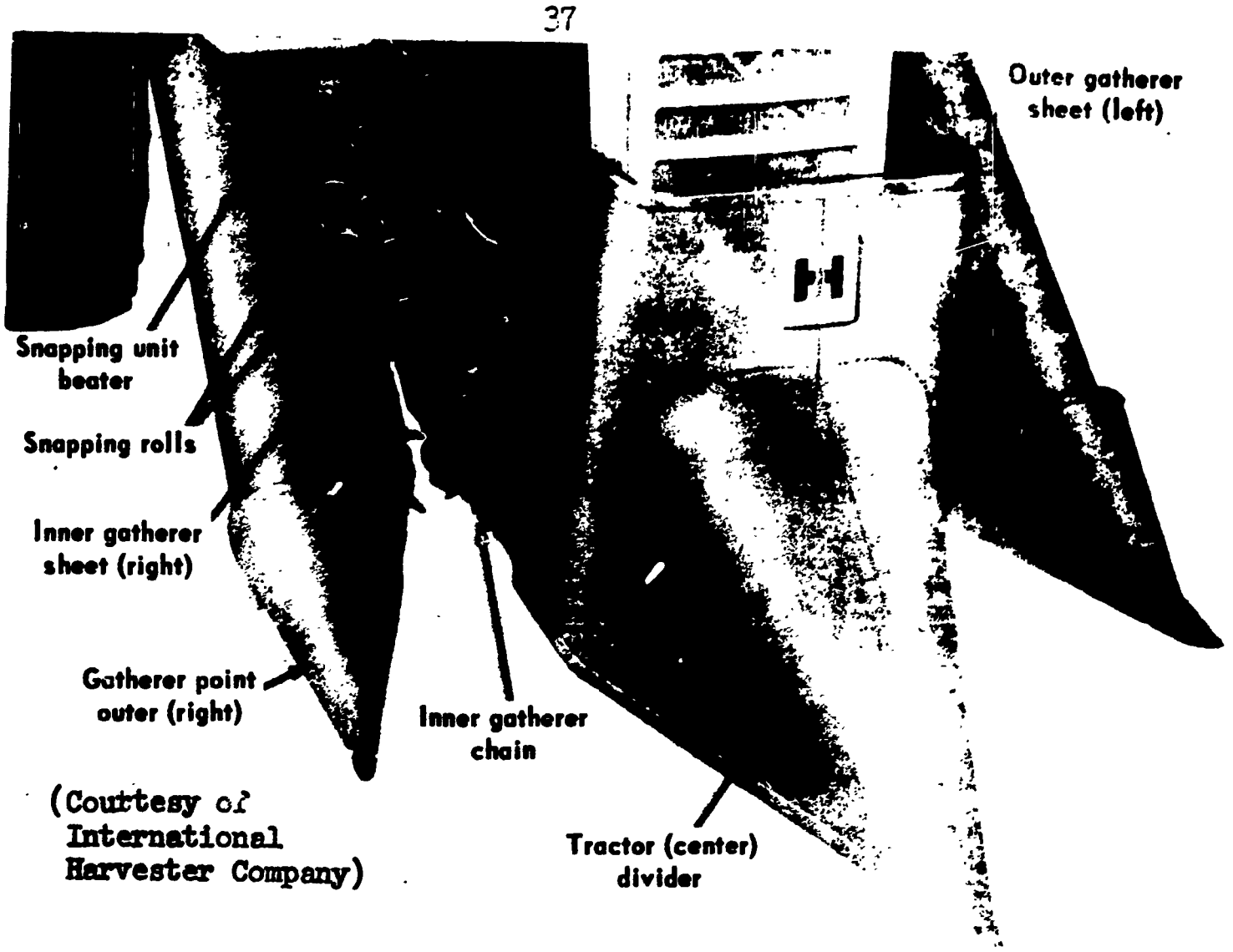


The Gathering Mechanism

1. Gathering points (Courtesy of John Deere Co.)
2. Gathering chains
3. Divider

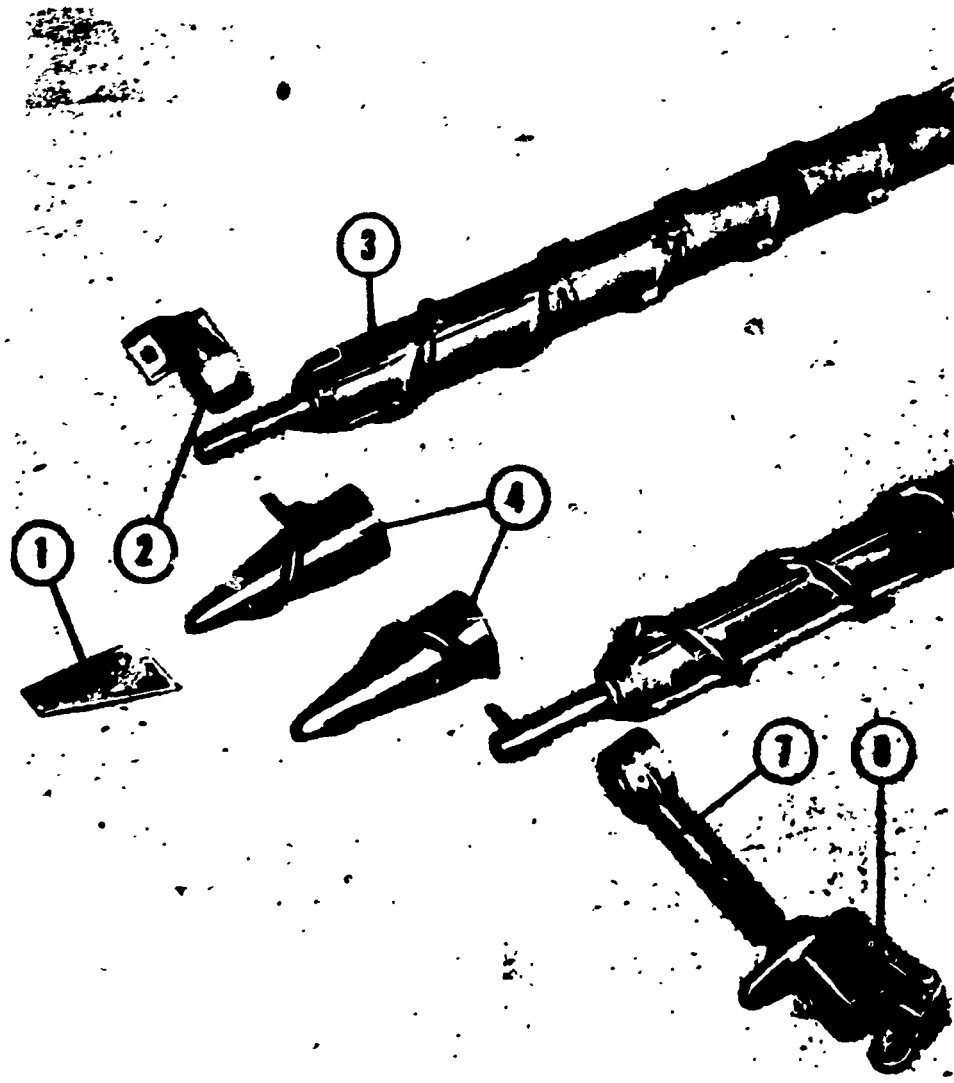
The gathering points direct the stalks into the throat of the gathering mechanism and up to the gathering chains. The gathering chains pull the stalks into the snapping rolls.

The snapping mechanism removes the corn ears from the corn stalk. This function is performed by two long, closely spaced rolls. The rolls slant upward and turn toward each other at a high speed. The snapping rolls are equipped with spiral lugs which grip onto the corn stalks and pull them down through the rolls. As the stalks are pulled down through the snapping rolls, the corn ear is pinched off the stalk and conveyed on to the husking rolls. The following illustrations show the gathering and snapping mechanisms and the parts breakdown of the snapping rollers.



(Courtesy of International Harvester Company)

GATHERING AND SNAPPING MECHANISMS



Snapping Rolls and Related Parts

1. Shield
2. Lower bearing
3. Outer roll
4. Live points
5. Bearing housing
6. Inner roll
7. Lower bearing
8. Linkage

After the ears have been snapped from the stalks, they are conveyed to the husking rolls. The husking rolls operate in pairs. One wall is usually rubber or rubber coated and the rolls rotate toward each other, similar to the action of the snapping rolls. The rolls are corrugated allowing the rolls to grasp and pull the husks from the ear. The husking mechanism of a corn picker is illustrated below.

Two types of husking rolls are commonly used on corn pickers.

1. Continuous or combination

   This type of husking roll is a continuation of the snapping roll. (See Farm Machinery and Equipment, page 347, for an illustration of this type of husking roll.)

2. Separate husking rolls (Illustrated above)

The corn ears are held against the husking rolls by a pressure plate allowing for a good clean job of husking with a minimum of shelling of kernels from the cob.

The cleaning mechanism on the corn picker consists of ejecting rolls and augers that remove trash and husks from the husking rolls, and discharge it to the ground and a fan that delivers a blast of air to blow off loose husks, leaves, pieces of stalks, and other trash.

As the husking rolls remove the husks from the ear, kernels may be shelled from the cob. These kernels drop onto the corn saver and are elevated into the wagon. The corn saving mechanism consists of a screen and a chain carrier. The chain carrier rakes off husks and trash keeping the screen clear.

The picker-sheller type of corn picker has an added mechanism, the shelling mechanism. Its function is to shell the corn ears as they come from the husking rolls. The shelling mechanism consists of a peg-studded cylinder that rotates inside a cylindrical screen. The shelled corn drops through the holes in the screen onto a set of sieves that agitate. The trash that comes through the cylindrical screen is blown away by a blast of air created by a fan located below the cylinder. The shelled corn falls through the sieves into the auger where it is augered into the wagon.

Suggested Teaching-Learning Activities

1. Bring a corn picker before the class disassembled to the point where all the movable parts can be seen, but yet, they are still functional. Demonstrate the operation of these parts before the class.

2. Have students disassemble completely a corn picker and learn its parts and their functions.

3. Demonstrate proper and improper corn picker operation under field conditions.

4. Bring to the class several combines of different makes that are in need of adjustment and repair. Follow the procedure below when making the needed adjustments and repairs.

   a. Operate the machine in the field noting any malfunctions in operation.

   b. Inspect the machine noting worn and broken parts and parts that are out of line or adjustment.

   c. Following the operator's and manufacturer's service manuals, make the necessary repairs and adjustments.

   d. Lubricate the machine for field operation.

   e. Test the machine in the field and make any adjustments necessary for proper operation.

Suggested Instructional Materials and References

Instructional materials

1. Corn pickers for complete disassembly
2. Machines for use in demonstrating proper and improper field operation

References

1. Machines for Power Learning, pp. 540-560.
2. Farm Machinery and Equipment, pp. 343-353.
3. Operator's manuals
4. Manufacturer's service manuals

VII. To prepare and paint crop harvesting machines after they have been repaired

Teacher Preparation

Subject Matter Content

If the persons being taught this module has not been taught the competency on preparing and painting crop harvesting machines included in the module on "Tractor Repair," they should be taught that competency at this time. The procedures outlines in that competency apply to painting crop harvesting machines as well as tractors.

Suggestions for Evaluating Educational Outcomes of the Module

The following criteria should be used to evaluate the educational outcome of this module.

1. Attentiveness in class and participation in laboratory activities
2. The ability of the student to use the operator's and manufacturer's service manuals
3. The ability of the student to perform the repair and adjustment activities on machines. As a final outcome, it is suggested that each student completely recondition a machine in need of repair and adjustment.

4. Employers evaluation of the ability of the student to adjust, repair, and service machines in his dealership

Source of Suggested Instructional Materials and References

1. Ridenour, H. E. Combines and Combining, Columbus, Ohio: The Ohio State University, Agricultural Administration Building, 2120 Fyffe Road, Department of Agricultural Education, 1965. Price: $.75.

2. Stone, A. A. and Gulvin, H. F. Machines for Power Farming, New York, New York: John Wiley and Sons, Inc., 1957. Price: $5.95.

3. Smith, N. P. Farm Machinery and Equipment, Fifth Edition, New York, New York: McGraw-Hill Book Company, 1964. Price: $10.50.

4. Operator's and manufacturer's service manuals from major line agricultural machinery manufacturers.

THE CENTER FOR RESEARCH AND LEADERSHIP DEVELOPMENT
IN VOCATIONAL AND TECHNICAL EDUCATION
THE OHIO STATE UNIVERSITY
980 KINNEAR ROAD
COLUMBUS, OHIO, 43212

INSTRUCTOR NOTE: As soon as you have completed teaching each module, please record your reaction on this form and return to the above address.

1. Instructor's Name_____

2. Name of school_____State_____

3. Course outline used: _____Agriculture Supply--Sales and Service Occupations
_____Ornamental Horticulture--Service Occupations
_____Agricultural Machinery--Service Occupations

4. Name of module evaluated in this report_____

5. To what group (age and/or class description) was this material presented?____
_____

6. How many students:
a) Were enrolled in class (total) _____
b) Participated in studying this module _____
c) Participated in a related occupational work experience program while you taught this module _____

7. Actual time spent teaching module:

		Recommended time if you were to teach the module again:
_____hours	Classroom Instruction	_____hours
_____hours	Laboratory Experience	_____hours
_____hours	Occupational Experience (Average time for each student participating)	_____hours
_____hours	Total time	_____hours

(RESPOND TO THE FOLLOWING STATEMENTS WITH A CHECK (✓) ALONG THE LINE TO INDICATE YOUR BEST ESTIMATE.)

	VERY APPROPRIATE	NOT APPROPRIATE
8. The suggested time allotments given with this module were:		
9. The suggestions for introducing this module were:		
10. The suggested competencies to be developed were:		
11. For your particular class situation, the level of subject matter content was:		
12. The Suggested Teaching-Learning Activities were:		
13. The Suggested Instructional Materials and References were:		
14. The Suggested Occupational Experiences were:		

(OVER)

15. Was the subject matter content sufficiently detailed to enable you to develop the desired degree of competency in the student? Yes_____No_____
Comments:

16. Was the subject matter content directly related to the type of occupational experience the student received? Yes_____No_____
Comments:

17. List any subject matter items which should be added or deleted:

18. List any additional instructional materials and references which you used or think appropriate:

19. List any additional Teaching-Learning Activities which you feel were particularly successful:

20. List any additional Occupational Work Experiences you used or feel appropriate:

21. What do you see as the major strength of this module?

22. What do you see as the major weakness of this module?

23. Other comments concerning this module:

(Date) (Instructor's Signature)

(School Address)